Tree and shrub insects of the prairie provinces

88-04581/

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Cover Illustration:

Forest tent caterpillar (*Malacosoma disstria*), by Dennis Lee.

TREE AND SHRUB INSECTS OF THE PRAIRIE PROVINCES

W.G.H. Ives and H.R. Wong

INFORMATION REPORT NOR-X-292

NORTHERN FORESTRY CENTRE
CANADIAN FORESTRY SERVICE
1988

*This publication was printed with funds provided by the
Canada-Alberta Forest Resource Development Agreement,
Canada-Saskatchewan Forest Resource Development Agreement, and
Canada-Manitoba Forest Renewal Agreement.*

©Minister of Supply and Services Canada 1988
Catalogue No. Fo46-12/292E
ISBN 0-662-15770-2
ISSN 0704-7673

This publication is available at no charge from:

Northern Forestry Centre
Canadian Forestry Service
5320 - 122 Street
Edmonton, Alberta
T6H 3S5

Ives, W.G.H.; Wong, H.R. 1988. *Tree and shrub insects of the prairie provinces*. Can. For. Serv., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-292.

ABSTRACT

More than 600 species of insects and mites that feed on trees and shrubs in the prairie provinces are discussed in terms of their distribution, hosts, and importance, life cycle and appearance, and damage. There are approximately 1100 color photographs; the life cycle and damage of major pest species are illustrated, and for less important species, primarily the larval stage is shown. Pests attacking coniferous hosts are separated from those attacking hardwoods, and each group is subdivided according to the kind of feeding damage and type of insect involved. An extensive bibliography is provided. In addition to a taxonomic index listing the order and family of each insect or mite, there is a diagnostic index listing the host species, feeding site of the pest, and species of insect or mite involved and an insect index.

RESUME

Ce rapport examine la répartition, les hôtes, l'importance, le cycle et les stades biologiques de plus de 600 espèces d'insectes et d'acariens qui parasitent les arbres et les arbustes des Prairies ainsi que les dégâts qu'ils causent. Il comprend près de 1 100 photographies en couleurs qui illustrent le cycle biologique des principales espèces de ravageurs et les dégâts qu'elles causent. Pour les espèces moins importantes, il s'agit surtout du stade larvaire. Les ravageurs sont divisés en deux groupes selon qu'ils attaquent les conifères ou les feuillus, chaque groupe étant lui-même subdivisé selon le type de dégâts infligés et le genre d'insecte en cause. Le rapport présente également une longue bibliographie. Outre un index taxonomique, donnant l'ordre et la famille de chaque insecte ou acarien, on trouvera un index pour diagnostic énumérant les espèces hôtes, l'organe attaqué et les insectes ou acariens en cause et un index des insectes.

ACKNOWLEDGMENTS

The publication of this report has been possible only because of the wholehearted cooperation of a large number of individuals. The authors are pleased to acknowledge their contributions.

The work was initiated and facilitated by our present and former program directors at the Northern Forestry Centre (NoFC), especially R.M. Waldron, Dr. S.S. Malhotra, and H.J. Johnson. Their continued support and encouragement have been deeply appreciated.

Dr. W.G. Evans (University of Alberta), Dr. B.H. Moody (Canadian Forestry Service, Ottawa), and Dr. W.J.A. Volney (chairman of the review committee, NoFC) were scientific reviewers. Valuable comments on the format of the publication were made by K. Knowles (Manitoba Department of Natural Resources), Dr. M.M. Pandila (Saskatchewan Department of Tourism and Renewable Resources), and R.S. Miyagawa (Alberta Forestry, Lands and Wildlife).

Most of the photographs were taken by P.S. Debnam (Photographic Section, NoFC), with the assistance of J.H. Baker. Other photographs were taken by the present and former staff of the Forest Insect and Disease Survey (FIDS) Unit (M. Grandmaison, G.N. Still, R.C. Tidsbury, F.J. Emond, J. Petty, V. Hildahl, and Dr. H.F. Cerezke). Additional photographs were obtained from Dr. G.A. Van Sickle (Pacific Forestry Centre), Dr. P.D. Syme (Great Lakes Forestry Centre), and Dr. D. Ostaff (Canadian Forestry Service—Maritimes).

Valuable assistance in the collecting of specific insects was provided by Dr. H.F. Cerezke, Dr. W.J.A. Volney, J.A. Drouin, C.L. Rentz, and by past and present members of the FIDS unit, particularly F.J. Emond, M. Grandmaison, J. Petty, and R.C. Tidsbury. First drafts of the taxonomic, diagnostic, and general indexes were prepared by P. Todd.

Most of the rearing, pinning, labeling, and shipment of specimens was done by D. Szlabey. Special thanks are extended to the director and staff of the Biosystematics Research Centre (BRC), Ottawa, for the prompt and courteous identification of the many specimens submitted to them for identification. Orthoptera were identified by Dr. V.R. Vickery of McGill University. We also wish to thank Dr. D.P. Dang (BRC) for kindly offering to check the scientific names for accuracy.

The library, computing, photographic, word processing, and editorial sections (NoFC) all contributed to the publication of this report. Because of the size of the report and the amount of work entailed, the authors would like to thank each of the individuals involved. The numerous references were obtained by D.J. Robinson and were sorted by A.W. Irwin and W. Hahn. The excellent color prints were prepared by J.H. Baker, and D. Lee mounted these prints onto the plates and prepared the excellent line drawings of insects. The manuscript was typed by J. Simunkovic; B. Boughton and J.K. Samoil edited it; and D.J. Adams did the typesetting. The whole publications section is to be complimented for their excellent work in preparing the report for publication.

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INTRODUCTION

This report on tree and shrub insects represents the culmination of the authors' extensive experience with forest insects of the prairie provinces. Each of the authors has devoted approximately 40 years to the study of forest entomology in this region. The report is not intended to be a textbook on forest entomology but rather a pictorial guide to aid in the identification of insects attacking trees and shrubs.

The authors have attempted to give a comprehensive coverage of the different types of insects affecting forest vegetation in the prairie provinces, but it has been impossible to include all species. Emphasis has been placed on the stage of the insect that causes the damage: this is usually the immature or larval stage. The different life stages are shown for most of the pest species, but space limitations have prevented depiction of the adults for most minor species except to illustrate some of the major groups.

The forest vegetation of the prairie provinces is less varied than that of either of the adjacent Canadian regions, although southeastern Manitoba and southwestern Alberta contain some of the trees from those regions (282, 489). Insects attacking these outlier tree species have been included in this report, even though their importance is often limited by the restricted distribution of their hosts. Coverage of host species has been limited to native trees and shrubs except for the widely distributed exotic species that are planted extensively in field and farmstead shelterbelts. Common names have been used for host species in order to conserve space. Scientific names are given in the diagnostic index.

Most of the insects illustrated in this report were collected by the senior author during brief collecting trips throughout the region, primarily in 1983–85. The immature forms were reared to the adult stage at the Northern Forestry Centre in Edmonton. Most of the adults were sent to specialists in Ottawa for identification or confirmation of local identifications. The remainder were sent to specialists elsewhere in Canada. Many of these insects are generally regarded as rare species, but this rarity may be more apparent than real, because the collection intensity was relatively low. Most of the identified rare insects have been included for the sake of completeness, but it is unlikely that they will become major pests.

The technical description of insects involves the use of many morphological features and terminology that may be unfamiliar to some readers of this report. We have therefore attempted to use familiar terms in our descriptions, but it has been impossible to avoid the use of some entomological jargon. The meanings of these terms are illustrated or defined in the following section. The major immature forms and the adult stages of these forms are depicted (Fig. 1) to enable the reader to recognize and become familiar with these groups. These definitions and illustrations should make the descriptions fairly easy to follow. This in turn should lead to at least a tentative identification of insects encountered.

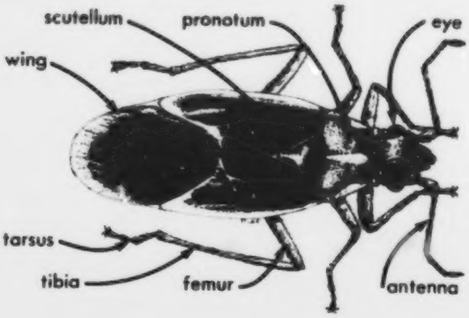
No recommendations on control methods are given in this report, to avoid having the information become outdated. Information on small-scale control measures can be obtained from almost any competent garden center if the identity of the pest is known. Large-scale control measures require prior authorization from the appropriate federal and provincial agencies. Personnel employed by these agencies can provide information on the best measures currently available for major pest-control operations.

Although a large number of references have been listed in the bibliography, it should be stressed that this report is not a review paper. Emphasis has been placed on papers published during the last 100 years that deal with adult or larval descriptions and with the biology of the various insects. These papers will provide interested readers with greater detail than was possible to present in the limited space of this report.

This report has been organized in a manner that should facilitate the recognition of an insect by someone not familiar with entomology. The insects have been grouped into two broad categories: those that feed on conifers and those that feed on hardwoods. Subsequent breakdowns are primarily on the basis of feeding damage rather than hosts, because many insects attack a variety of hosts. Whenever feasible, similar insects have been placed together to facilitate comparison. This also serves to demonstrate that superficial descriptions are often inadequate for positive specific identification; however, more detailed descriptions are beyond the scope of this report. It is often unnecessary to know the exact species of insect encountered, however, provided the type of insect can be recognized, so that this inadequacy is not as serious as it might seem.

The nomenclature of insects is everchanging. Checklists are available for Diptera (560), Lepidoptera (268), and Hymenoptera (323), but even these lists soon become outdated. We have attempted to use the most current scientific names, and we have followed the Canadian lists of common names (36, 37). The order and family for each of the insects discussed are listed in the taxonomic index, because space did not allow us to give this information in the text.

Finally, here are a few suggestions on how our readers might use this report as an aid to insect identification. First, the insect index gives the scientific and common names of the species that are discussed. Secondly, the table of contents and list of figures indicate the various types of damage on coniferous and hardwood hosts. Thirdly, the diagnostic index provides a breakdown of damage for each host species and gives a more comprehensive host list for general feeders than could be given in the text.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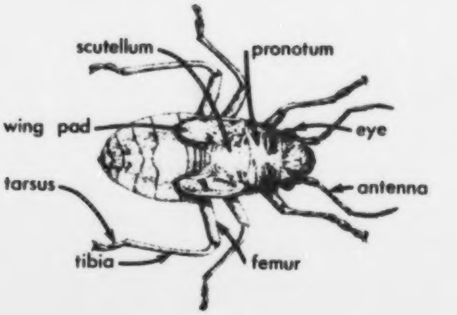
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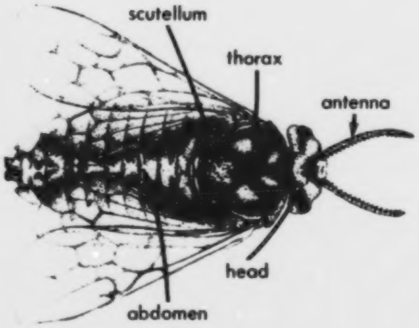
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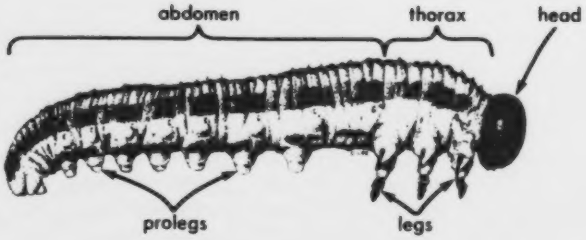
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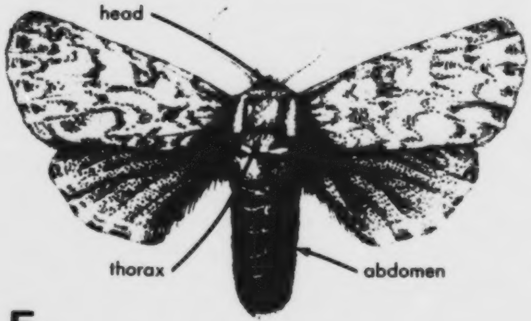
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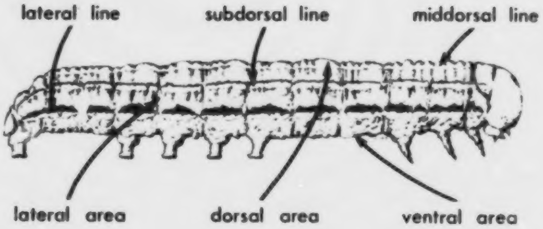
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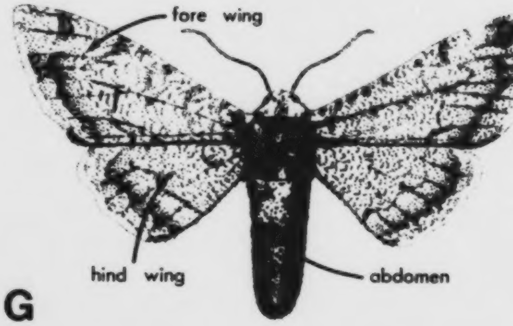
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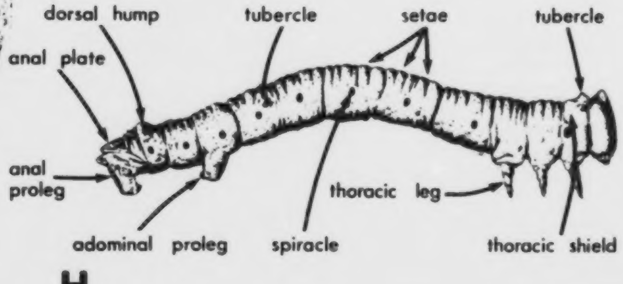
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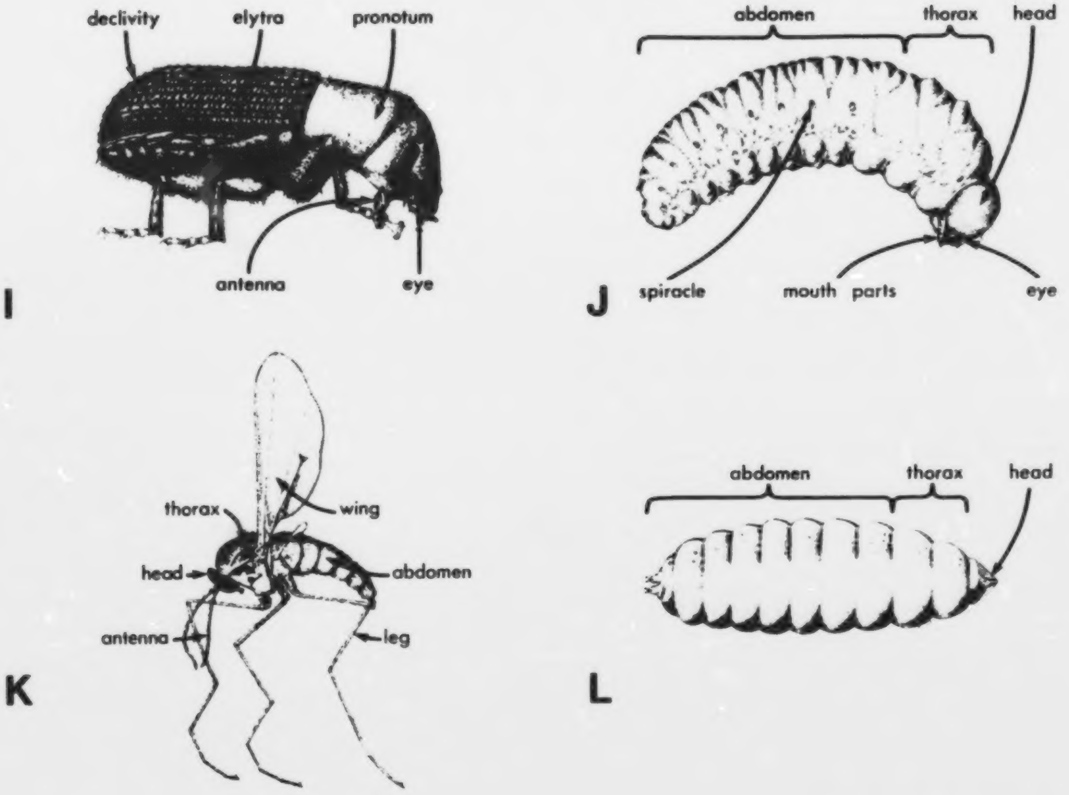


Figure 1. Some terms used to describe insects. A. Plant bug adult. B. Plant bug nymph. C. Sawfly adult. D. Sawfly larva. E. Climbing cutworm adult. F. Climbing cutworm larva. G. Looper adult. H. Looper larva. I. Bark beetle adult. J. Bark beetle larva. K. Midge adult. L. Midge larva.

SOME TERMS USED TO DESCRIBE INSECTS

The structure of adult and immature insects, like all arthropods, differs from other animals in that their skeletons are external. The skeletons of immature insects do not grow continuously but increase in size intermittently. The immature insect sheds its skin, or skeleton, and replaces it with another, usually larger one, in a complex physiological process known as molting.

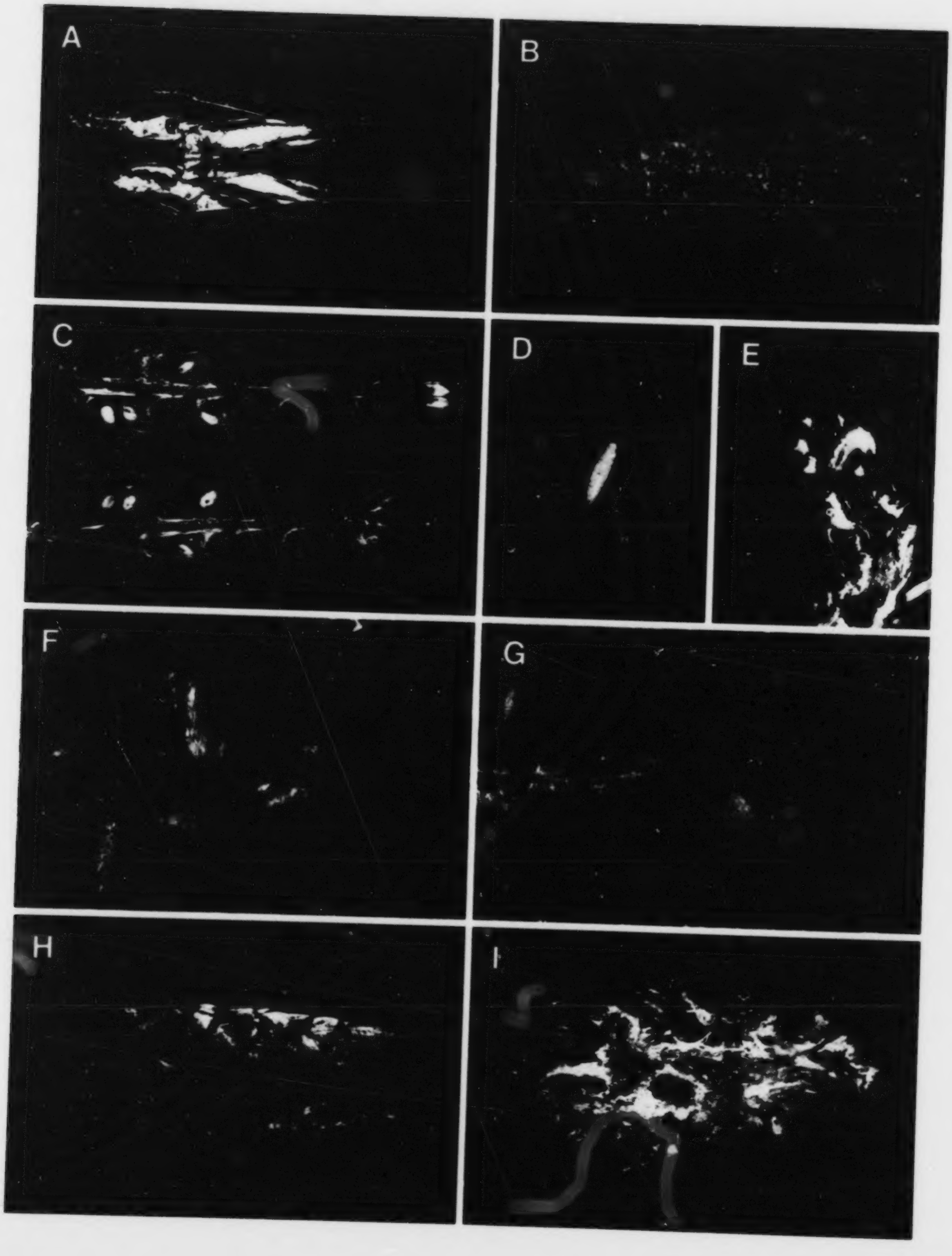
The immature forms of some insects, such as plant bugs (A, B), resemble the adults and are referred to as nymphs. These insects are said to undergo incomplete metamorphosis. The immature forms of most insects, including sawflies (C, D), climbing cutworms (E, F), loopers (G, H), bark beetles (I, J), and midges (K, L) bear no resemblance to the respective adults and are known as larvae. These insects are said to undergo complete metamorphosis.

The use of a number of technical terms has been unavoidable in describing the immature and mature insects in this report. These terms are defined through illustration in Figure 1. Terms not defined in a college dictionary and that cannot be clearly illustrated are defined here in a brief glossary.

Crawler: An immature scale insect in the active crawling stage.
Cremaster: The terminal abdominal segment of a pupa.
Exarate: A pupa in which the legs and wings are free from the body.
Frass: The solid excrement of insects.
Introduced insect: An insect that is not native to a continent.
Pheromone: A chemical given off by an organism to induce a behavioral or physiological response in another organism of the same species.
Puparium: The hardened, barrel-like last skin in which the pupa of flies is formed.
Setal base: A small hardened area at the base of a slender hairlike bristle (seta).

Bibliography: 126, 151, 537, 553

INSECTS ATTACKING CONIFERS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SEED AND CONE INSECTS (Figure 2)

Distribution, Hosts, and Importance

Several species of minute flies and wasps feed in seeds and cones and are important pests, especially in seed orchards. Other species are of little economic importance. Primitive sawflies in the genus ***Xyela*** feed on the pollen in the staminate cones of various pines.

The spruce cone maggot, ***Delia anthracina*** (Czerny), attacks Engelmann, white, and black spruce cones and may destroy all of the seed crop in some years. ***Delia laricicola*** (Karl) feeds in the cones of tamarack and alpine larch. The spruce cone gall midge, ***Dasineura canadensis*** Felt, and the spruce cone axis midge, ***D. rachiphaga*** Tripp, are two other common midges in spruce cones. They destroy only a few seeds even when they are very abundant. The spruce seed midge, ***Mayetiola carpophaga*** (Tripp), and an unidentified midge, ***Resseliella*** sp., attack the seeds and cones of white spruce, respectively, but are seldom abundant. Several ***Megastigmus*** species feed within the seeds of various conifers and are important pests. All species are host specific, but several species attack the seeds of true firs, so that identification of these is difficult. The spruce seed chalcid, ***M. atedius atedius*** Walker, is an important pest in the prairie provinces.

Life Cycle and Appearance

Xyela bakeri Konow adults (A) are small black sawflies about 4 mm long. The larvae (B) are cream colored, almost legless, and are 4–5 mm long at maturity. ***Delia anthracina*** has one generation per year, overwintering in puparia in the duff. Adults emerge in early spring just before the spruce cones start to develop. The flies are about 6 mm long and look like small houseflies. The females lay eggs singly between the scales of recently pollinated cones. There are three larval instars. The larvae feed spirally around the cone axis (C), then drop to the ground in midsummer to form puparia. Little is known about the life cycle of ***D. laricicola*** (D, E) but it is probably similar to that of *D. anthracina*.

Dasineura canadensis and ***D. rachiphaga*** have similar life cycles. Both species have one generation per year, overwintering as larvae in silken cocoons within the cones. Pupation occurs in early spring, and the adults emerge in early May. They are slender-legged flies about 2 mm long. The females deposit their eggs on the outer surface of the new cone scales. Those of *D. canadensis* are near the middle of the scales, and those of *D. rachiphaga* are at the base or on the rachis. Larvae of *D. canadensis* bore through the scale and cause small gall-like swellings on the inner surface. The galls enlarge as feeding progresses and are plainly visible from both sides of the scale by the time the larvae mature in mid-July. Fully grown larvae are orange and are about 3 mm long. The larvae cut emergence holes near the outer end of the gall, then seal the opening with silk. A silken cocoon is then spun (F) in which the larva overwinters. Development of *D. rachiphaga* larvae is similar, except that they feed in the rachis, where they spin their cocoons (F). Fully grown larvae are yellowish orange and are about 3 mm long.

Mayetiola carpophaga has one generation per year, overwintering as larvae in cocoons within the seeds. Adults emerge in May or June and are about 2.5 mm long. Larvae enter the seeds through the micropyles. Each larva completes development in a single seed, is pinkish yellow in color, and is about 3 mm long at maturity (G). ***Resseliella*** sp. larvae feed on the surface of the scales within the cones. They range in color from yellowish to bright orange (H).

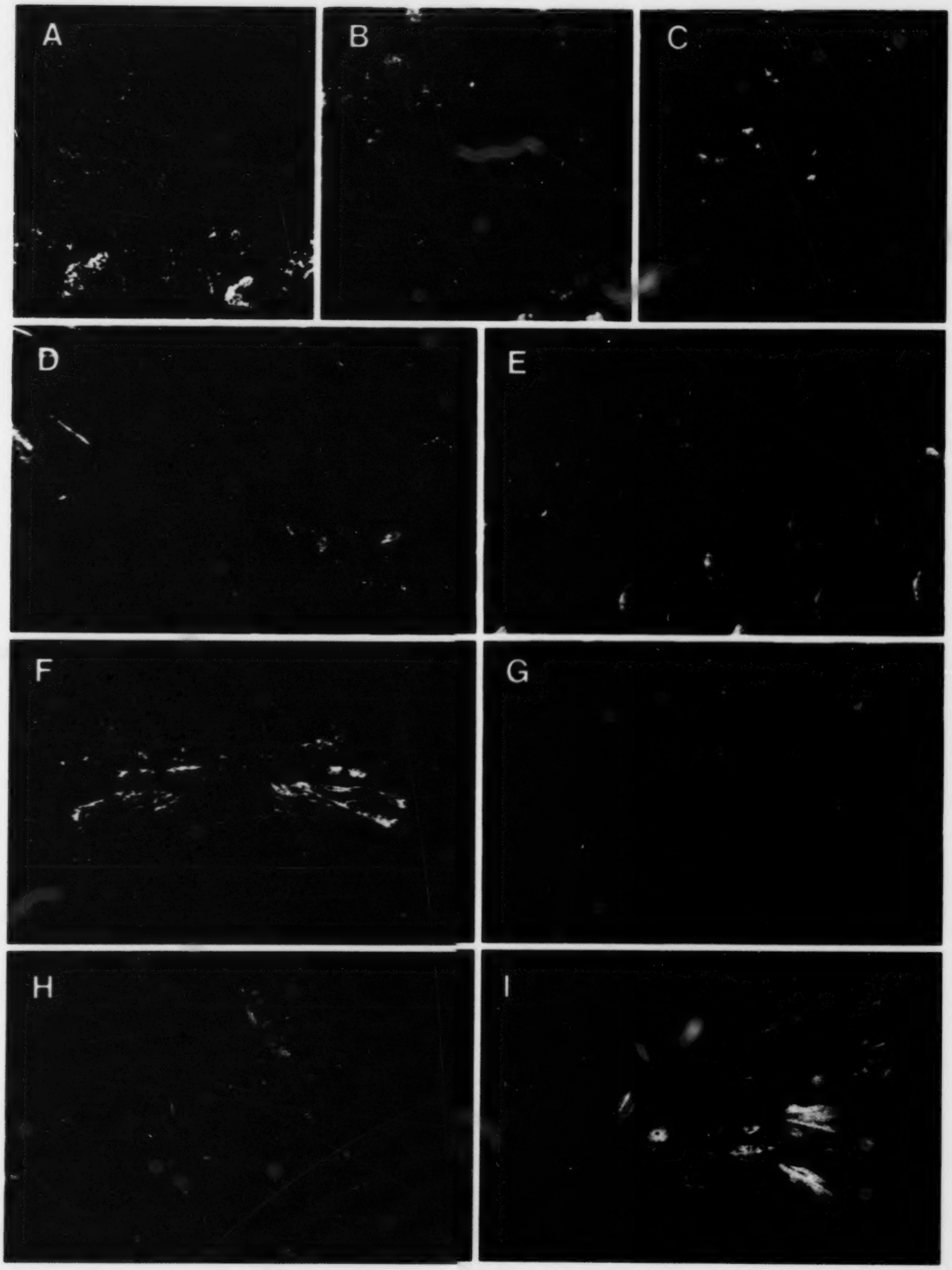
The different species of ***Megastigmus*** have similar life histories. All have one generation per year, overwintering as larvae within the seeds. Adults emerge in the spring. The females insert their eggs into the young seeds, usually one per seed. The larvae complete development within the seeds without any external evidence of their presence. They have five instars and are yellowish white in color (G), but some mature larvae may appear darker because of the large fat bodies that show through the transparent integument.

Damage

Delia anthracina is a voracious feeder, and its spiral tunnel may destroy most seeds in white spruce cones (C). ***Delia laricicola*** causes similar damage to tamarack cones (E). Many white spruce seeds are destroyed by ***Megastigmus atedius atedius*** (G), but much of this damage is not detected because there is no external evidence of damage. Other species cause little seed loss (F, H, I) because they feed within the scales or rachis, but their galls and feeding damge may interfere with seed release.

Bibliography: 249, 252, 413, 542, 574, 576

Figure 2. Seed and cone insects. A. Female adult *Xyela bakeri* Konow. **B.** *X. bakeri* larva. **C.** White spruce cone damaged by the spruce cone maggot, *Delia anthracina* (Czerny), larva. **D.** *D. laricicola* (Karl) egg on tamarack cone. **E.** Tamarack cone damaged by an unidentified insect (probably *D. laricicola)*. **F.** Spruce cone gall midge, *Dasineura canadensis* Felt, and spruce cone axis midge, *D. rachiphaga* Tripp, cocoons in a scale and rachis, respectively, of a white spruce cone. **G.** Spruce seed midge, *Mayetolia carpophaga* (Tripp), (lower) and spruce seed chalcid, *Megastigmus atedius atedius* Walker, (upper) in seeds of white spruce. **H.** Unidentified larvae (possibly *Resseliella* sp.) on surface of white spruce cone. **I.** Black spruce cone damaged by unidentified insects.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LEPIDOPTEROUS CONE INSECTS AND ASSOCIATES (Figure 3)

Distribution, Hosts, and Importance

Larvae of many species of moths damage the seeds and cones of coniferous trees in North America. They may be conveniently arranged into three groups. The first group includes defoliators associated with the cone-feeding insects. They sometimes damage young cones superficially while feeding, but their effect on the seed crop is minimal. The most important examples in the prairie provinces are the spruce budworm, ***Choristoneura fumiferana*** (Clemens) (Fig. 6), and the jack pine budworm, ***C. pinus*** Freeman (Fig. 5). ***Archips alberta*** (McDunnough) and the spruce needleworm, ***Herculia thymetusalis*** (Walker), also fall into this category and are part of a complex of species feeding in the dense tops of black spruce.

The second group includes the cone worms that bore into the cones and destroy many seeds. They may also eat foliage, especially if cones are scarce. The spruce coneworm, ***Dioryctria reniculelloides*** Mutuura & Munroe, and the fir coneworm, ***D. abietivorella*** (Grote), on pines, spruces, true firs, and Douglas-fir are important examples in the prairie provinces.

The third group includes the insects that complete their development within the cones. This important group is represented in the prairie provinces by the spruce seed moth, ***Cydia strobilella*** (Linnaeus), which attacks the seeds of most spruces, and the Douglas-fir cone moth, ***Barbara colfaxiana*** (Kearfott), which attacks Douglas-fir cones. Another species whose range may extend into the region is the eastern pine seedworm, ***C. toreuta*** (Grote), which attacks the seeds of a variety of pines.

Life Cycle and Appearance

The life cycles of the spruce and jack pine budworms are discussed under defoliators of conifers (Figs. 5 and 6). Little is known about the life histories of *A. alberta* and *H. thymetusalis*. ***Archips alberta*** probably has one generation per year, overwintering as young larvae in mined needles. The mature larvae have smoky gray bodies, are about 20 mm long, and have black heads and thoracic shields (E). Adults are present from mid-July to October. The moths have a wingspan of 24–27 mm, are yellowish brown in color with shades of pink, and have dark brown and black markings. The limited information on the life history of ***H. thymetusalis*** indicates that 2 years are required to complete development. The larvae apparently overwinter in the fourth and seventh instars. Mature larvae are about 20 mm long, have buff-colored bodies with five broken longitudinal dark lines, and have dark brown heads and thoracic shields (D). Adults emerge between late May and early July. The moths have a wingspan of about 20 mm. The front wings are reddish brown with two yellow crescent-shaped marks on the leading edge and two black transverse lines dividing the wings into thirds. The hind wings are buff with a curved black line near the middle of the wing.

Dioryctria reniculelloides has one generation per year, overwintering as young larvae. The larvae feed on foliage, staminate flowers, or cones until late June or early July, when they reach a length of about 17 mm (A). The head is dark brown, and the body is pale yellow with closely spaced dorsal cinnamon stripes flanked by dark brown subdorsal bands. Adults have a wingspan of about 25 mm. The front wings are narrow and are brownish gray in color. The hind wings are pale brown. ***Dioryctria abietivorella*** has one generation per year, overwintering as prepupae in cocoons. The moths have narrow gray front wings and whitish gray hind wings. The larvae feed in a variety of sites, including the cones (B). Young larvae have brown heads and amber bodies but become darker when mature and develop rows of brown spots along their backs. Fully grown larvae are about 20 mm long.

Cydia strobilella has one generation per year, overwintering in the larval stage. Pupation occurs within the cones in the spring. The adults emerge in late May. They are smoky brown moths with silver bars and spots on the front wings (F) and have a wingspan of 8–11 mm. Females lay eggs between the bud scales, and the young larvae burrow towards the developing ovules. The larvae feed on the ovules until September. Mature larvae are cream colored with brown heads and thoracic shields (G). The larva spins a silken tube or cocoon in the spring just before pupating. ***Cydia toreuta*** has a similar life history, except that it attacks 2nd-year pine cones. The adults are chocolate brown in color, with darker brown markings on the front wings.

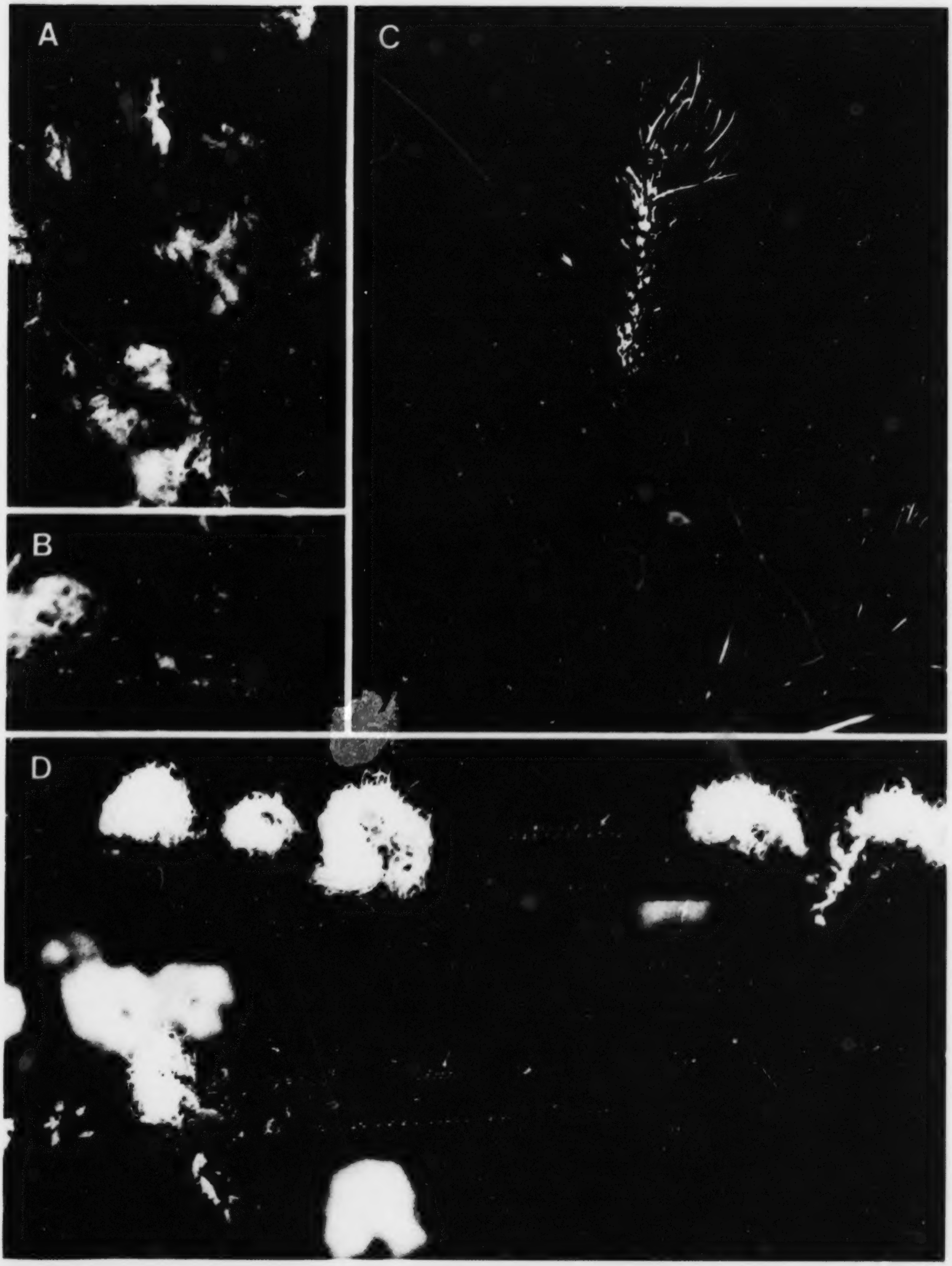
Barbara colfaxiana has one generation per year, overwintering in the pupal stage. Adults have a wingspan of 15–20 mm and emerge in early spring. The front wings are grayish brown with transverse bands. The hind wings are unmarked. The larvae have cream-colored bodies and brown heads. They feed on the developing ovules and pupate in the cone (H).

Damage

The feeding of these larvae may seriously damage cones (C, H) or cause distortion in their growth (I). Seed crops on spruce and Douglas-fir can be almost completely destroyed if the cone crop is poor. Such damage is particularly serious in seed orchards, where ***Dioryctria*** larvae may cause further damage by attacking the graft union.

Bibliography: 139, 203, 251, 252, 303, 345, 348, 421, 428, 481, 492, 575, 578, 634, 644

Figure 3. Lepidopterous cone insects and associates. **A.** Spruce coneworm, *Dioryctria reniculelloides* Mutuura & Munroe, larva. **B.** Fir coneworm, *D. abietivorella* (Grote) larva. **C.** Black spruce cones damaged by *Dioryctria* sp. larvae. **D.** Spruce needleworm, *Herculia thymetusalis* (Walker). **E.** *Archips alberta* (McDunnough) larva. **F.** Spruce seed moth, *Cydia strobilella* (Linnaeus). **G.** *C. strobilella* larva in rachis of white spruce cone. **H.** Douglas-fir cone moth, *Barbara colfaxiana* (Kearfott), pupa in Douglas-fir cone. **I.** Douglas-fir cone infested with *B. colfaxiana*.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WOOLLY APHIDS (Figure 4)

Distribution, Hosts, and Importance

Woolly aphids have complicated life cycles involving sexual and parthenogenetic forms. Some woolly aphid species alternate between different host species, while others have simplified life cycles on one host. The Cooley spruce gall adelgid, ***Adelges cooleyi*** (Gillette), alternates between spruce and Douglas-fir when both hosts are present but is capable of existing on either host if the other is missing. It causes the formation of galls on spruce (Fig. 24) but only produces flocculence on Douglas-fir. The hard pine adelgid, ***Pineus coloradensis*** (Gillette), feeds on the stems and needles of lodgepole pine and a variety of other western pines. It produces flocculence, but no galls are formed. Neither insect is of economic importance in the forest, but either can sometimes become abundant in Christmas tree plantations or on ornamentals.

Life Cycle and Appearance

The host-alternating form of ***A. cooleyi*** requires 2 years to complete its complicated life cycle. Only the parthenogenetic forms on Douglas-fir will be discussed here; the gall-forming and sexual stages are discussed in the section on spruce galls (Fig. 24). The winged adults emerging from the galls on spruce in late summer fly to Douglas-fir and settle on the lower surface of the new needles, where they deposit their eggs. The nymphs overwinter on the new needles. They develop into adults the following spring. Adults secrete curled strands of white wax over their bodies, creating tufts (D). Each female deposits a cluster of eggs that soon becomes light brown in color. The nymphs hatching from these eggs develop into two types of adults. The majority become winged females that migrate to spruce, and the remainder develop into wingless females that remain on the Douglas-fir. Little is known about subsequent development on Douglas-fir, but apparently some individuals are able to continue to reproduce on this host if spruces are not in the vicinity. A form of *A. cooleyi* on spruce that does not produce galls has been reported. It overwinters as a first-instar nymph and develops into a wingless, parthenogenetic adult in about mid-June. Oviposition is completed by late June or early July, and the nymphs hatch in about 1 week. Most of the nymphs settle on the underside of the older needles, where they remain without molting until the following spring.

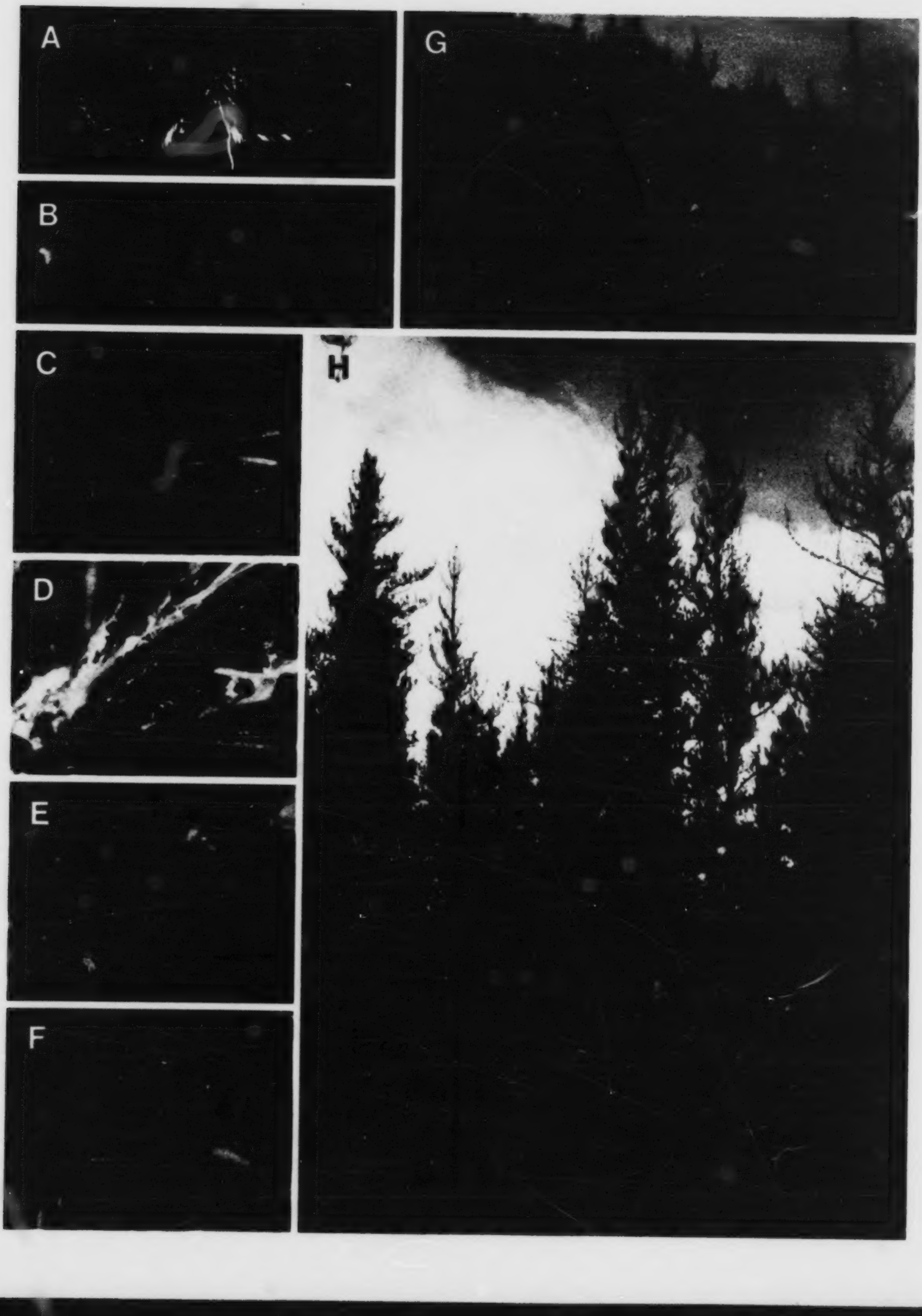
Little is known about the life history of ***P. coloradensis***. Wingless parthenogenetic adults (A, B) secrete white waxy filaments that cover their bodies, and they are apparently capable of reproducing indefinitely on the same host. Winged adults have been described, but no alternate hosts have been recorded, and it is not known if they reinfest the original host species.

Damage

Severe infestations of either of these woolly aphids cause a yellowing of foliage (C), which often leads to premature needle drop, especially on poor sites. The damage is usually not extensive enough to become a problem under forest conditions but can be serious in Christmas tree plantations, where the loss of needles and flocculence reduces the value of the trees.

Bibliography: 9, 119, 121, 139, 203

Figure 4. Woolly aphids. A. Hard pine adelgid, *Pineus coloradensis* (Gillette), under cottony masses. **B.** *P. coloradensis* adult with cottony mass removed. **C.** Three-year-old lodgepole pine infested with *P. coloradensis*. **D.** Eggs and crawlers (nymphs) of the Cooley spruce gall adelgid, *Adelges cooleyi* (Gillette), on Douglas-fir. Note eggs and crawlers on lower needle.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PINE BUDWORMS (Figure 5)

Distribution, Hosts, and Importance

The jack pine budworm, ***Choristoneura pinus*** Freeman, belongs to a group of closely related defoliators of coniferous trees. In the mid-1920s biologists recognized that the *Choristoneura* species on jack pine was different from the one on white spruce and balsam fir. Populations on jack pine were elevated to species rank in 1953. Jack pine is the principal host, but Scots pine, eastern white pine, red pine, lodgepole pine, white spruce, and tamarack are also attacked. The jack pine budworm is the major defoliator of jack pine in the Lake States, northwestern Ontario, Manitoba, and parts of Saskatchewan. No major outbreaks have been reported on jack pine or lodgepole pine in Alberta, although the insect has been found there. Outbreaks typically last 2 or 3 years, with recurrences every 6–8 years. A closely related species, the sugar pine tortrix, ***Choristoneura lambertiana*** (Busck), has caused light defoliation of limber pine in the foothills of southern Alberta. Lodgepole pine was not damaged, but outbreaks of this insect have been reported on lodgepole pine in Idaho and Montana.

Life Cycle and Appearance

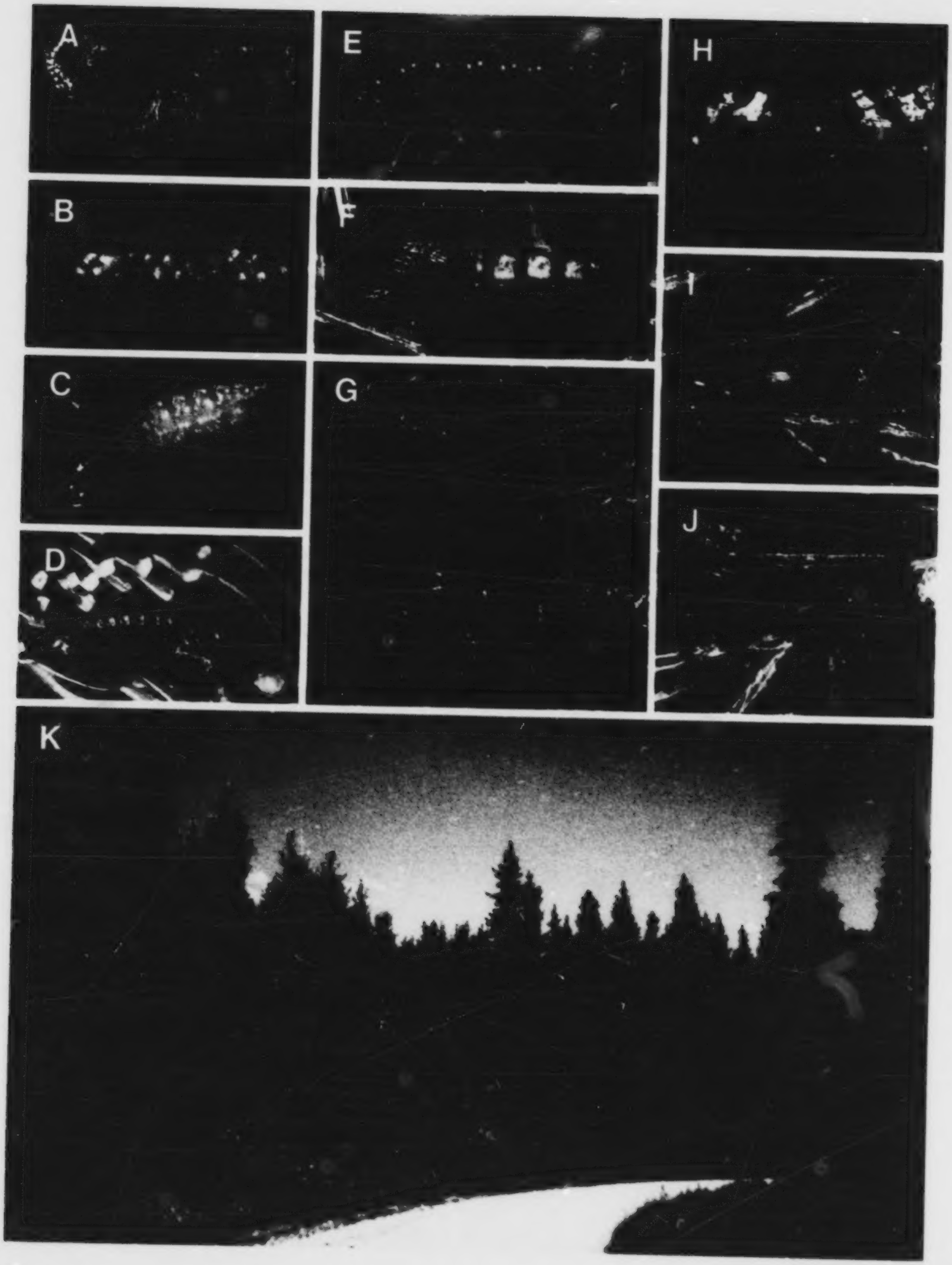
Second-instar larvae of *C. **pinus*** have yellowish bodies with dark brown heads, and they emerge from hibernation more or less coincident with the opening of the host's staminate flowers. On trees bearing staminate flowers the young larvae feed in the flower clusters, often completely riddling them. Older larvae may use the staminate flower cluster as a shelter tunnel from which to feed on nearby foliage. Apparently, some can feed in the flowers until pupation. Mature larvae are 20–22 mm long and differ in color from the earlier instars. The head is light brown to black, and the dark brown thoracic shield is separated from the head by a narrow white band. The body is reddish brown with yellowish sides. There are two rows of white dots along the back (E). The habit of feeding along the side of the shoot in a web shelter or tunnel (D) is the most common on nonflowering trees, but some of the young larvae bore into the needle sheath and eat the needle off at the base. Pupae are formed in the tunnels. They wriggle out of these tunnels before the adults emerge but remain suspended by the cremaster, which becomes entangled in the silk lining of the tunnel (F). Adults have a wingspan of 15–28 mm and emerge in late July and early August. The front wings are reddish brown with silver markings (A), and the hind wings are gray. Females lay their eggs in double rows on the concave side of the needles (B, C). The larvae hatch in a few days. They do not feed but form hibernacula beneath bark scales and needle sheaths before molting to the second instar for overwintering.

Damage

Choristoneura pinus larvae are wasteful feeders. They cut the needles off at the base and eat only the basal portion, leaving the rest entangled in a mass of silk. As the foliage dries, it turns a reddish brown color (G). Severely defoliated trees have thinned crowns, and there is often top kill (H). Tree mortality is usually minimal and occurs mainly among the smaller suppressed trees, unless the outbreak is accompanied by a severe drought.

Bibliography: 58, 124, 139, 192, 195, 218, 271, 292, 325, 326, 327, 346, 374, 464

Figure 5. Pine budworms. A. Adult jack pine budworm, *Choristoneura pinus* Freeman. **B.** Close-up of eggs on needle. **C.** Eggs on Scots pine needles. **D.** Late-instar larva in needles. **E.** Late-instar larva in staminate flowers. **F.** Pupa attached to foliage by its cremaster. **G.** Brown needles caused by larval feeding. **H.** Jack pine stand following budworm attack.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BUDWORMS ON SPRUCE (Figure 6)

Distribution, Hosts, and Importance

The spruce budworm, ***Choristoneura fumiferana*** (Clemens), and the eastern blackheaded budworm, ***Acleris variana*** (Fernald), are the most common budworms in this region. Both species feed on a variety of hosts including balsam fir, white spruce, and black spruce. Although *C. fumiferana* prefers mature balsam fir as a host, several severe outbreaks have occurred in the prairie provinces and Northwest Territories in white spruce stands containing little or no balsam fir. *Acleris variana* has not caused severe damage in the prairie provinces. Two close relatives of the spruce budworm also occur in the prairie provinces but are not shown. The two-year-cycle budworm, ***Choristoneura biennis*** Freeman, attacks Engelmann spruce and alpine fir in the Rocky Mountain parks. The western spruce budworm, ***C. occidentalis*** Freeman, a pest of Douglas-fir in western Canada, has been found in Alberta, but no outbreaks have occurred.

Life Cycle and Appearance

Choristoneura fumiferana has a 1-year life cycle. There are six larval instars. Second-instar larvae emerge from hibernation in late April or May. The young larvae (C) are yellowish and have dark brown heads and thoracic shields. They mine needles, unopened buds, or male flowers and feed within the expanding shoots (D). Mature larvae are 18–24 mm long and have black heads and reddish brown bodies that are lighter in color on the sides (E). The thoracic shield is brown and is separated from the head by a whitish band. There are two rows of whitish spots along the back. The larvae usually web two or three shoots together to form a feeding tunnel. Pupae (F) are formed among the foliage in June and are attached to the silk lining of the feeding tunnel by the cremaster. Adults (A) emerge in late June or July. They have a wingspan of about 20 mm and are variable in color. The fore wings are usually dull gray with bands and spots of brown, and the hind wings are light gray. The eggs (B) are green and are deposited in clusters of about 20 (range 1–60 or more) on the needles of the host tree. The eggs hatch in about 10 days, and the tiny larvae disperse among the foliage on silken threads. The first-instar larvae spin hibernacula under bark scales and molt to the second instar without feeding. ***Choristoneura occidentalis*** has a similar life history, as does ***C. biennis***, except that the latter has a 2-year life cycle and overwinters twice in the larval stage.

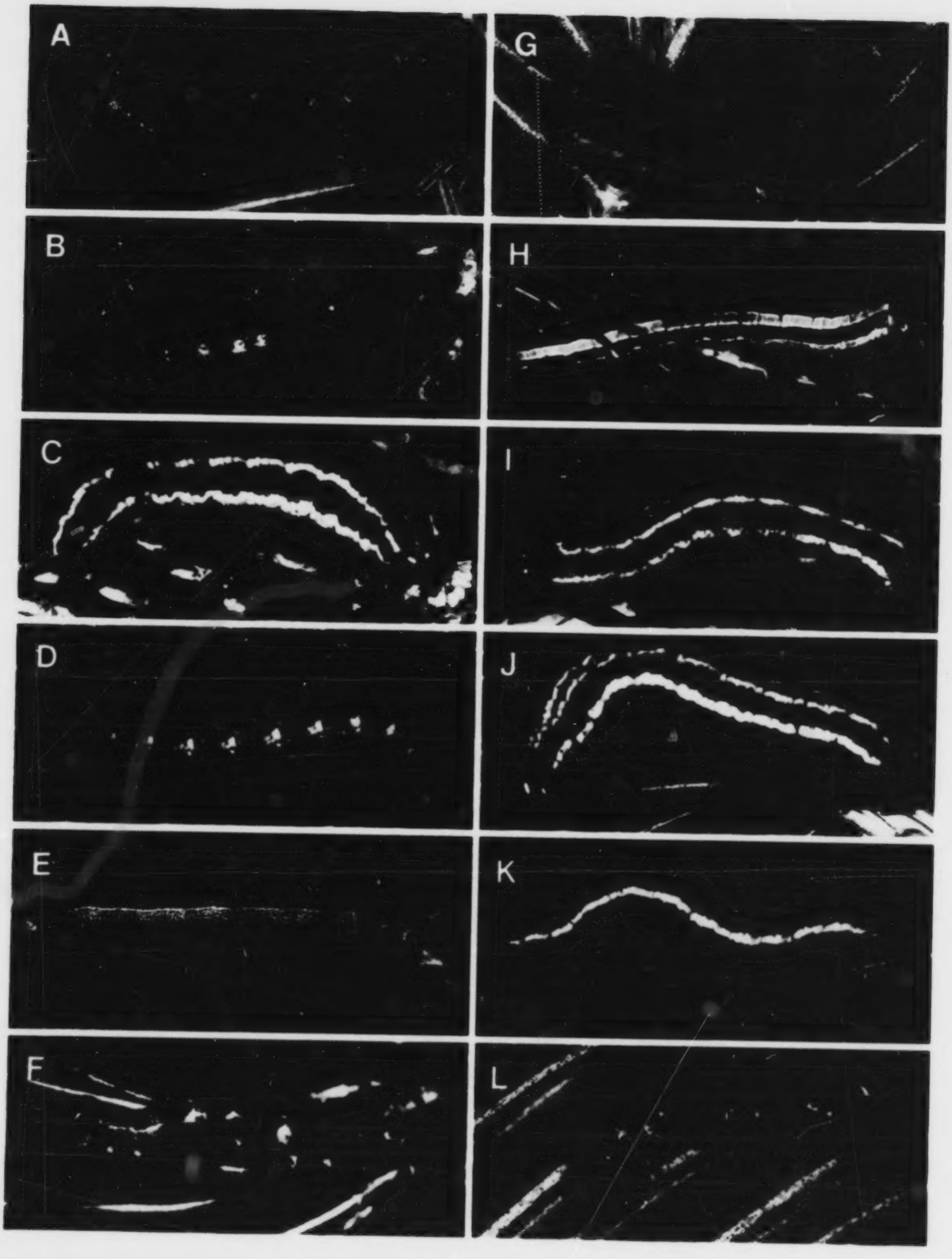
Acleris variana has a 1-year life cycle. The insect overwinters as an egg laid singly on the undersurface of the needles. The eggs hatch in June. The young larvae feed in the developing shoot and have dark brown or black heads and a green or yellowish green body (I). Fully grown (fifth-instar) larvae are 11–15 mm long. The head color varies from reddish brown to dark brown or black, the thoracic shield is mainly dark brown or black, and the body is light green (J). Adults emerge in August, have a wingspan of about 20 mm, and are variable in coloration. The fore wings are usually gray or dark gray with white bands (H) but may also be ocherous or reddish with yellowish bands. The hind wings are dark gray.

Damage

Choristoneura fumiferana is a wasteful feeder, eating the needles at the base and leaving the remainder entangled in a mass of silk. As the foliage dries it assumes a reddish color (K) until washed off by heavy rains, when the true amount of defoliation becomes evident (G). Short periods of defoliation by the spruce budworm cause a marked reduction in radial increment; prolonged outbreaks cause severe branch and, ultimately, tree mortality. Balsam fir is more susceptible than white or black spruce. ***C. biennis*** causes similar damage, but the broods are synchronized, so that intense feeding occurs in alternate years, making the cumulative defoliation effects less deleterious.

Bibliography: 47, 48, 72, 166, 195, 222, 292, 406, 407, 419, 452, 496, 511, 512, 567, 579

Figure 6. Budworms on spruce. A. Adult spruce budworm, *Choristoneura fumiferana* (Clemens). **B.** *C. fumiferana* egg mass. **C.** Second-instar *C. fumiferana* larva. **D.** Young *C. fumiferana* larva in new shoot. Some needles have been cut off to reveal larva. **E.** Mature *C. fumiferana* larva. **F.** *C. fumiferana* pupa. **G.** Close-up of *C. fumiferana* feeding damage. **H.** Adult eastern blackheaded budworm, *Acleris variana* (Fernald). **I.** Young *A. variana* larva on new shoot. **J.** Mature *A. variana* larva. **K.** White spruce stand defoliated by *C. fumiferana.*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THE SPRUCE HARLEQUIN AND ITS ALLIES (Figure 7)

Distribution, Hosts, and Importance

Several species of heavy-bodied lepidopterous larvae, mostly relatives of cutworms, are commonly found feeding on conifers in the prairie provinces. Unless otherwise noted, they are of no economic importance and have a widespread distribution.

The spruce harlequin, ***Palthis angulalis*** (Hübner), and the fir harlequin, ***Elaphria versicolor*** Grote, both feed on balsam fir, white spruce, and a variety of other conifers. *Elaphria versicolor* is an eastern species whose range extends into southeastern Manitoba. The chameleon caterpillar, ***Anomogyna elimata*** (Guenée), attacks jack pine, balsam fir, white spruce and other conifers. The gray spruce cutworm, ***A. perquiritata*** (Morrison), feeds primarily on balsam fir and white spruce, and ***Lithophane thaxteri*** Grote feeds on tamarack. The pine false looper, ***Zale duplicata*** (Bethune), attacks jack pine and lodgepole pine and is most abundant in southeastern Manitoba and southwestern Alberta.

The spruce epizeuxis, ***Idia aemula*** Hübner, the joker, ***Feralia jocosa*** (Guenée), the spruce climbing cutworm, ***Syngrapha alias interalia*** (Ottolengui), the angulated cutworm, ***S. rectangula*** (W.F. Kirby), and the spruce false looper, ***S. viridisigma*** (Grote), all feed on balsam fir, white spruce, and many other conifers. ***Melanchra pulverulenta*** (Smith) feeds primarily on larch, and ***Clemensia albata*** (Packard) attacks mainly white spruce and balsam fir and is most common in central Alberta.

Life Cycle and Appearance

The spruce harlequin and its allies all have one generation per year. Most overwinter in the pupal stage, but *C. albata* probably overwinters as a young larva. The adults are heavy bodied, gray, brown, or greenish moths with a wingspan of 20–40 mm. The hind wings are usually unmarked, but the front wings are speckled, blotched, or striped, mostly with darker colors.

Palthis angulalis larvae (A) have dusky brown heads and bodies, and the latter is covered with coarse granules. Their abdomens have a dorsal hump near the rear with a whitish diagonal line leading to it and a dark middorsal line with oblique dorsal markings on each side. The larvae are about 22 mm long at maturity. ***Elaphria versicolor*** larvae (B) resemble those of *P. angulalis*, but they have smooth skins and two dorsal humps, one near each end of the abdomen. The pale white middorsal line expands laterally into three conspicuous white subdorsal patches.

Anomogyna elimata larvae (C) have greenish brown heads with vertical brown marks. Their bodies are green with conspicuous white middorsal, subdorsal, and lateral lines. There is a brown color-phase with similar markings. Mature larvae are about 25 mm long. ***Anomogyna perquiritata*** larvae (D) have gray heads and bodies, both marked with brownish black reticulations and spots. There is an irregular yellowish white spot in front of each spiracle. Mature larvae are about 30 mm long. ***Lithophane thaxteri*** larvae (E) have light green heads and bodies covered with white granulations and are about 30 mm long at maturity. They have faint white middorsal, subdorsal, and lateral lines.

Zale duplicata larvae (F) are extremely variable in coloration and markings. Some larvae may be entirely gray, others are reddish brown, and others are whitish with black and brown markings. The larvae are slender, move with a looping action, and are about 30 mm long at maturity. The anterior pair of prolegs are reduced, and the posterior pair usually extend beyond the end of the body. ***Idia aemula*** larvae (G) have brownish heads and pinkish bodies. They have poorly defined dusky middorsal and subdorsal stripes, each seta has a dark spot at its base, and the larvae are about 20 mm long at maturity.

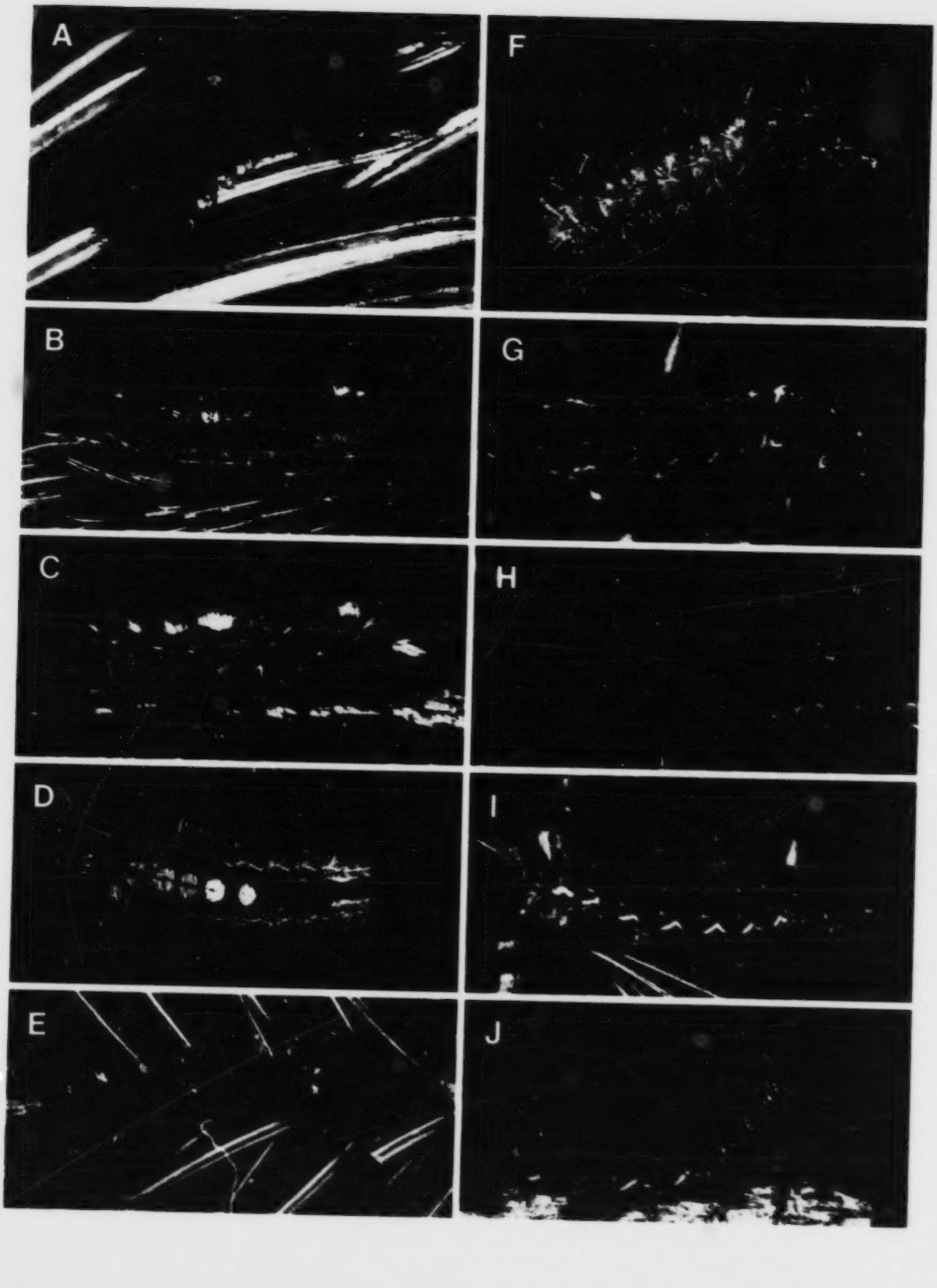
Melanchra pulverulenta larvae (H) have greenish brown heads and conspicuously striped green and yellow bodies. There may be a pair of dark middorsal lines and the green and yellow stripes are usually separated by a thin dark line. Fully grown larvae are about 30 mm long. ***Feralia jocosa*** larvae (I) have green heads and bodies with conspicuous white middorsal, subdorsal, and lateral lines. There is a red line immediately above the lateral white line, and fully grown larvae are about 30 mm long. ***Syngrapha alias interalia*** larvae (J) also have green heads and bodies and reach a length of about 25 mm when mature. They have a pair of middorsal white lines and a prominent subdorsal white line, and the two anterior pairs of prolegs are missing. ***Syngrapha rectangula*** larvae (not shown) are almost identical to those of *S. alias interalia*. ***Syngrapha viridisigma*** larvae (K) have yellowish green bodies and pale yellow subdorsal lines but are otherwise very similar to the other two species. ***Clemensia albata*** larvae (L) have dark heads with a whitish horizontal band across the face. Their bodies are whitish and heavily marked with black, and the larvae reach a length of about 20 mm at maturity.

Damage

None of these larvae are ever abundant enough to damage their hosts.

Bibliography: 67, 116, 139, 188, 189, 350, 372, 391, 456, 474, 477

Figure 7. The spruce harlequin, *Palthis angulalis* (Hübner), and its allies. A. *P. angulalis* **larva. B.** Fir harlequin, *Elaphria versicolor* Grote, larva. **C.** Chameleon caterpillar, *Anomogyna elimata* (Guenée). **D.** Gray spruce cutworm, *A. perquiritata* (Morrison). **E.** *Lithophane thaxteri* Grote larva. **F.** Pine false looper, *Zale duplicata* (Bethune). **G.** Spruce epizeuxis, *Idia aemula* Hübner, larva. **H.** *Melanchra pulverulenta* (Smith) larva. **I.** Joker, *Feralia jocosa* (Guenée), larva. **J.** Spruce climbing cutworm, *Syngrapha alias interalia* (Ottolengui). **K.** Spruce false looper, *S. viridisigma* (Grote). **L.** *Clemensia albata* (Packard) larva.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HAIRY OR SPINY LARVAE ON CONIFERS (Figure 8)

Distribution, Hosts, and Importance

The larvae of several diverse genera of moths feeding on conifers are characterized by conspicuous hairs or setae and are here treated as a group. Except where noted, all species occur throughout the prairie provinces but are of no economic importance. The smoky moth, ***Eilema bicolor*** (Grote), is believed to feed on lichens but has been reared successfully on the foliage of white spruce, balsam fir, and several other conifers.

The northern conifer tussock moth, ***Dasychira plagiata*** (Walker), attacks white spruce, balsam fir, and a variety of other conifers in Manitoba. ***Dasychira grisefacta*** (Dyar), a western species ranging east to Saskatchewan, feeds on Douglas-fir, white spruce, pine, and other conifers. The pine tussock moth, ***D. pinicola*** (Dyar), attacks pine and may occur in southeastern Manitoba. The rusty tussock moth, ***Orgyia antiqua*** (Linnaeus), and the whitemarked tussock moth, ***O. leucostigma*** (J.E. Smith), are general feeders that attack both coniferous and hardwood hosts.

The larch lappet moth, ***Tolype laricis*** (Fitch), feeds on white spruce, balsam fir, tamarack and other conifers. ***Acronicta lanceolaria*** (Grote) feeds on tamarack, red pine, and some hardwood hosts. The tufted white pine caterpillar, ***Panthea furcilla*** (Packard), feeds primarily on pines. The tufted spruce caterpillar, ***P. acronyctoides*** (Walker), attacks spruces, tamarack, pines, and Douglas-fir. ***P. pallescens*** McDunnough feeds on pines and tamarack.

Life Cycle and Appearance

All of these insects have one generation per year in the prairie provinces. The three *Dasychira* species overwinter as small larvae, *A. lanceolaria* and the three *Panthea* species overwinter as pupae, and the rest overwinter in the egg stage.

The fore wings of ***E. bicolor*** adults span about 25 mm and are medium gray with a pale orange stripe along the leading edge. The hind wings are a lighter gray. The larvae have black heads and gray bodies with pale orange subdorsal stripes and are about 20 mm long at maturity (A). They are armed with spines arising from several tubercles on each body segment. *Dasychira* adults are brown-gray moths with a wingspan of 25-37 mm. Fully grown larvae are about 37 mm long. They are brown or gray in color, with four dorsal tufts, two black pencils at the front, and three pencils at the rear. ***Dasychira plagiata*** larvae (B) have a single lateral row of clavate, plumose black hairs when mature, while ***D. grisefacta*** larvae (C) have two rows. ***Dasychira pinicola*** larvae (not shown) resemble those of *D. plagiata*. The life cycles of ***O. antiqua*** (D) and ***O. leucostigma*** have been discussed elsewhere (Fig. 61). Larvae of *O. leucostigma* resemble *O. antiqua* except that the lateral pencils are missing and the dorsal tufts are white.

Tolype laricis adults are gray moths with a wingspan of about 30 mm. The larvae are gray, about 25-30 mm long when fully grown, and have a row of small paired hairless tubercles along the back (E). The body is flattened and has a ventral row of tubercles along each side. Each of these tubercles bears a number of long fine hairs. The fore wings of ***A. lanceolaria*** span 45-50 mm. The wings are white and densely sprinkled with black, which gives them a bluish gray appearance. The hind wings are white. Mature larvae are about 35 mm long (F). The head and body are green, and the tubercles are light green. The spiracles and lateral bands are black, and there is a black strip along the backs of the larvae. The setae on the sides of the body are longer than the rest.

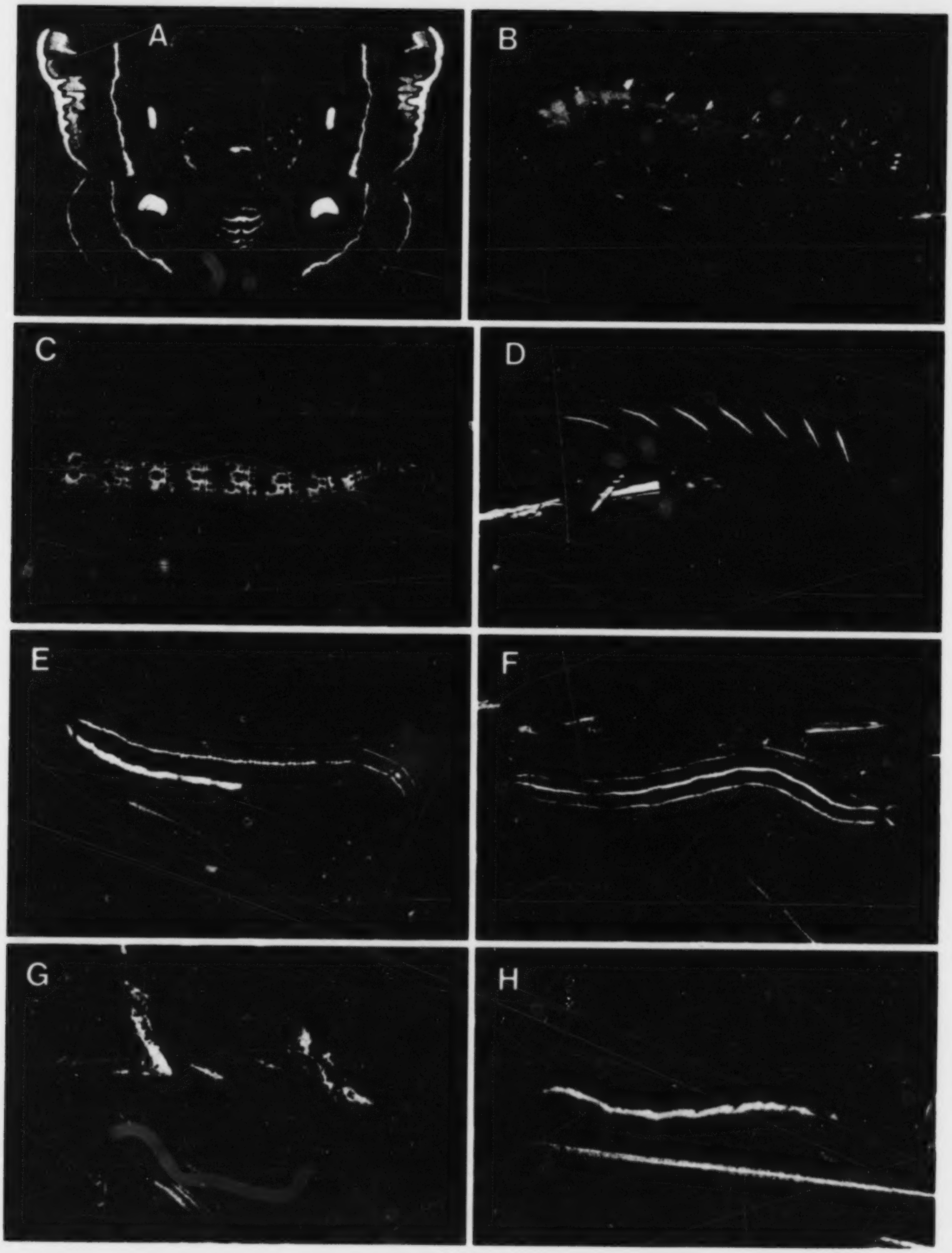
The front wings of ***P. furcilla*** span 35-50 mm and are gray, dusted with black, and have a thick black transverse line. The hind wings are whitish with a smoky edge and base. The larvae have white heads with numerous reddish brown dots. The body is brownish, flecked with black, and each segment has several brown to brick-red warts, each bearing several slender hairs (G). There is an irregular white dorsal line along the abdomen, and the spiracles are white, surrounded by smoky black. ***Panthea acronyctoides*** adults resemble *P. furcilla* except that the ground color of the front wings is white, and each front wing has a black spot unless it is obliterated by heavy black dusting. The larvae have velvety black bodies heavily overlaid with white markings and are about 35 mm long when mature (H). The warts on the body are light brown, and each bears a cluster of gray hairs. The hairs arising from the subdorsal warts on the prothorax and on the first and eighth abdominal segments form short pencils. The upper bodies of some larvae are completely black, except for the warts, each of which bears a number of creamy white hairs (I). Larvae of ***P. pallescens*** (J) are almost identical to the light color phase of *P. acronyctoides*.

Damage

None of these insects have caused sufficient defoliation to damage trees.

Bibliography: 65, 66, 116, 139, 182, 188, 190, 203, 391, 456, 475, 534

Figure 8. Hairy or spiny larvae on conifers. A. Smoky moth, *Eilema bicolor* (Grote), larva. **B.** Northern conifer tussock moth, *Dasychira plagiata* (Walker), larva. **C.** *D. grisefacta* (Dyar) larva. **D.** Rusty tussock moth, *Orgyia antiqua* (Linnaeus), larva. **E.** Larch lappet moth, *Tolype laricis* (Fitch), larva. **F.** *Acronicta lanceolaria* (Grote) larva. **G.** Tufted white pine caterpillar, *Panthea furcilla* (Packard), larva. **H.** Tufted spruce caterpillar, *P. acronyctoides* (Walker), larva. **I.** Black color phase of *P. acronyctoides* larva. **J.** *P. pallescens* McDunnough larva.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COLORFUL OR BIZARRE LARVAE ON CONIFERS (Figure 9)

Distribution, Hosts, and Importance

Several species of caterpillars have been grouped together here because of their colorful or bizarre appearance. None are of economic importance.

The larch silkworm, ***Hyalophora columbia*** (S.I. Smith), is a rare species that feeds on tamarack in southeastern Manitoba. The fireweed caterpillar, ***Alypia langtoni*** Couper, usually feeds on fireweed throughout the region but is occasionally found on tamarack. The apple sphinx, ***Sphinx gordius*** Cramer, feeds on tamarack in all three prairie provinces. The pine tree sphinx, ***Lapara bombycoides*** Walker, is found primarily on jack pine and occurs as far west as Saskatchewan.

The filament bearer, ***Nematocampa limbata*** (Haworth), feeds on Douglas-fir, balsam fir, white spruce, tamarack, and a variety of other softwoods and hardwoods throughout the region. The pine elfin, ***Incisalia niphon clarki*** Freeman, feeds primarily on jack pine in Manitoba and Saskatchewan. ***Incisalia eryphon*** (Boisduval) attacks lodgepole pine in western Alberta.

Life Cycle and Appearance

All of these insects have one generation per year and overwinter in the pupal stage. ***Hyalophora columbia*** adults (A) have a wingspan of 80–100 mm and emerge in late spring or early summer. The basal parts of the wings are reddish and variously suffused with black, and the outer parts are gray with whitish purple edges. There are two irregular white lines across the wings; one is near the base, and the other separates the reddish and gray areas. There is a black and blue spot near the tip of the front wing, and each wing has a conspicuous white spot. The larvae (B) are bluish green and reach a length of about 75 mm when mature. There are paired, red, middorsal tubercles on the second and third thoracic and first abdominal segments. Each pair of the remaining middorsal tubercles is white and tinged with yellow, and the rest of the tubercles are white. The larvae spin tough, spindle-shaped cocoons on bog shrubs. Adults and larvae of this species are very similar to those of *H. gloveri nokomis* (Brodie) (Fig. 59).

Alypia langtoni adults have a wingspan of about 25 mm and emerge in June. The wings are black. Males have two white spots on each wing. Females have two white spots on each front wing but only one on each hind wing. The larvae (C) have yellowish heads and reach a length of about 30 mm. The dorsal half of the body is white with black and yellowish orange markings, and each body segment has several conspicuous black tubercles. ***Sphinx gordius*** adults are grayish, tinged with brown, and marked with black. They have a wingspan of 70–85 mm. The larvae (D) are yellowish green and reach a length of about 50 mm at maturity. The spiracles are red, and each of the first seven abdominal segments has an oblique white band. These bands have an anterior red border when the larvae are young, but the border turns purplish as the larvae mature.

Lapara bombycoides adults have a wingspan of 50–60 mm. The front wings are marked with alternating light and dark gray bands, the former with semicircular notches facing outwards, and the hind wings are brownish gray. Young larvae (E) have a pointed green head with an inverted yellow V down the sides of the face. The body is green, with paired white middorsal lines and white subdorsal and lateral lines. There is no caudal horn. The face on older larvae (F) is reddish brown, and patches of reddish purple occur between the paired middorsal lines. This purplish color sometimes replaces most of the green on the body. ***Nematocampa limbata*** adults are cream or straw colored with a wingspan of 20–25 mm. The larvae (G) have mottled brown and gray bodies with paired middorsal tubercles on the first abdominal segment and long paired middorsal filaments on the second and third abdominal segments. ***Incisalia niphon clarki*** and ***I. eryphon*** are very similar in both the adult and larval stages. The adults are small blackish or brownish butterflies with white markings and have a wingspan of about 30 mm. The larvae (H) are flattened and sluglike in shape. The body is green, covered with short hairs, and has a white middorsal and lateral line.

Damage

None of these insects cause enough defoliation to damage their hosts.

Bibliography: 181, 187, 189, 266, 391, 457, 474, 475

Figure 9. **Colorful or bizarre larvae on conifers.** **A.** Adult larch silkworm, *Hyalophora columbia* (S.I. Smith). **B.** *H. columbia* larva.* **C.** Fireweed caterpillar, *Alypia langtoni* Couper. **D.** Apple sphinx, *Sphinx gordius* Cramer, larva. **E.** Young pine tree sphinx, *Lapara bombycoides* Walker, larva. **F.** Mature *L. bombycoides* larva. **G.** Filament bearer, *Nematocampa limbata* (Haworth). **H.** *Incisalia eryphon* (Boisduval) larva.

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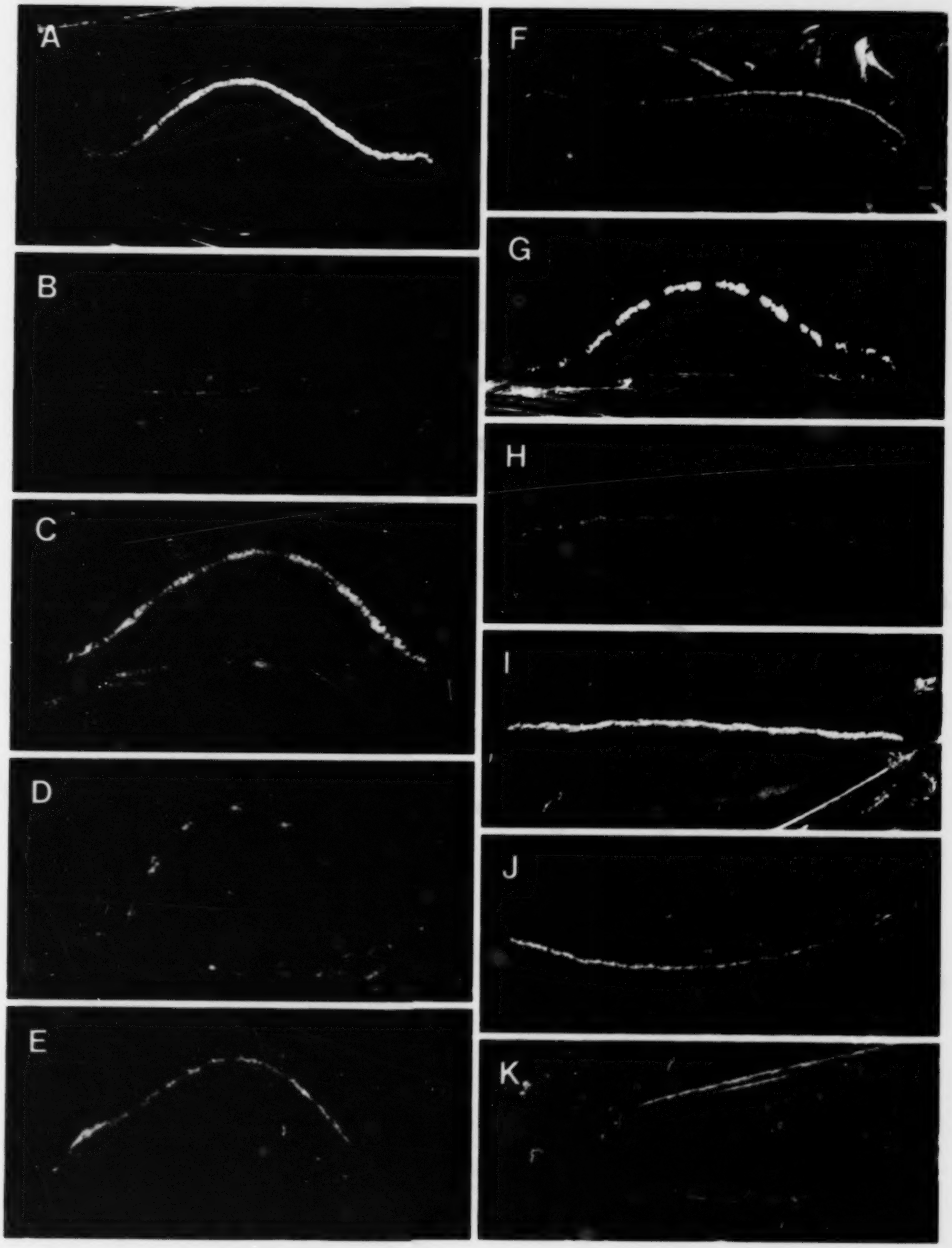
* Photograph courtesy of Great Lakes Forestry Centre.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THE FALSE HEMLOCK LOOPER AND SOME OF ITS ALLIES (Figure 10)

Distribution, Hosts, and Importance

Several species of *Nepytia* and *Semiothisa* are commonly found feeding on conifers in the prairie provinces, but none are of economic importance in this region.

The false hemlock looper, ***N. canosaria*** (Walker), feeds on spruce, balsam fir, white cedar, tamarack, and pine. It occurs as far west as Saskatchewan. A closely related species, the western false hemlock looper, ***N. freemani*** Munroe, attacks Douglas-fir and other conifers in British Columbia and southwestern Alberta. ***Nepytia umbrosaria nigrovenaria*** (Packard) also occurs in southwestern Alberta, where it feeds primarily on Douglas-fir.

Semiothisa setonana (McDunnough) feeds on Rocky Mountain juniper in southwestern Alberta. The spruce-fir looper, ***S. signaria dispuncta*** (Walker), attacks most conifers and has a transcontinental distribution. Older Canadian records erroneously referred to this species as *S. granitata* (Guenée). Owen's larch looper, ***Semiothisa oweni*** (Swett), feeds primarily on tamarack but will occasionally attack most conifers, and the jack pine looper, ***S. bicolorata*** (Fabricius), feeds primarily on jack pine. The ranges of both species extend as far west as Alberta. The green larch looper, ***S. sexmaculata*** (Packard), feeds exclusively on larch and is found throughout the prairie provinces wherever its host occurs.

Life Cycle and Appearance

Nepytia canosaria has one generation per year and overwinters in the egg stage. The moths have gray heads, gray wings flecked with black, and wingspans of 25–40 mm. Fully grown larvae are 25–30 mm long and occur in two color phases. One has a brown head with conspicuous black spots, a whitish body with a reddish brown dorsal band, and numerous wavy black subdorsal and lateral lines (A). The other has similar black markings, but the head and body are light green (B). ***Nepytia freemani*** adults resemble those of *N. canosaria* but have yellowish markings on top of the head. Their larvae resemble the brown phase of *N. canosaria*. ***Nepytia umbrosaria nigrovenaria*** overwinters in the larval stage. Mature larvae (C) reach a length of about 35 mm and also resemble the brown phase of *N. canosaria*, but the spots on the head are smaller and the black lines are less distinct.

Canadian *Semiothisa* species have one generation per year and overwinter in the pupal stage. The adults have a wingspan of 15–30 mm. They may be white, light gray, or light brown, depending upon the species, and they usually have dots and crosslines on the front wings. The females lay their eggs singly or in groups at the base of needles or on the filaments of lichen if these are present. The larvae feed on new foliage and pass through five or six instars before pupating.

Semiothisa setonana larvae reach a length of about 20 mm in the sixth instar (D). The head is light green with faint but darker herringbone markings. The body may be gray-green or green; it has a pair of middorsal gray lines, a broken subdorsal white line, and a pair of black or gray lines below this. There are oblique black lines above most spiracles and a white patch in front of each. ***Semiothisa signaria dispuncta*** larvae reach a length of about 25 mm in the sixth instar (E, F). The head is yellowish green with brown herringbone markings. The body is light-to-medium green with gray and white lines down the back and along the sides. Field observations suggest that larvae on Douglas-fir (E) are generally lighter in color than those on spruce or balsam fir (F). ***Semiothisa oweni*** larvae reach a length of about 17 mm at maturity. There are two color phases, which look entirely different except for a white lateral line that is broken in the brown phase (G) but is continuous in the green phase (H). The broken white lateral line separates the brown phase from other brown loopers on conifers, and the conspicuous pair of dark subdorsal lines and host help to separate the green phase from *S. signaria dispuncta* and other striped green loopers.

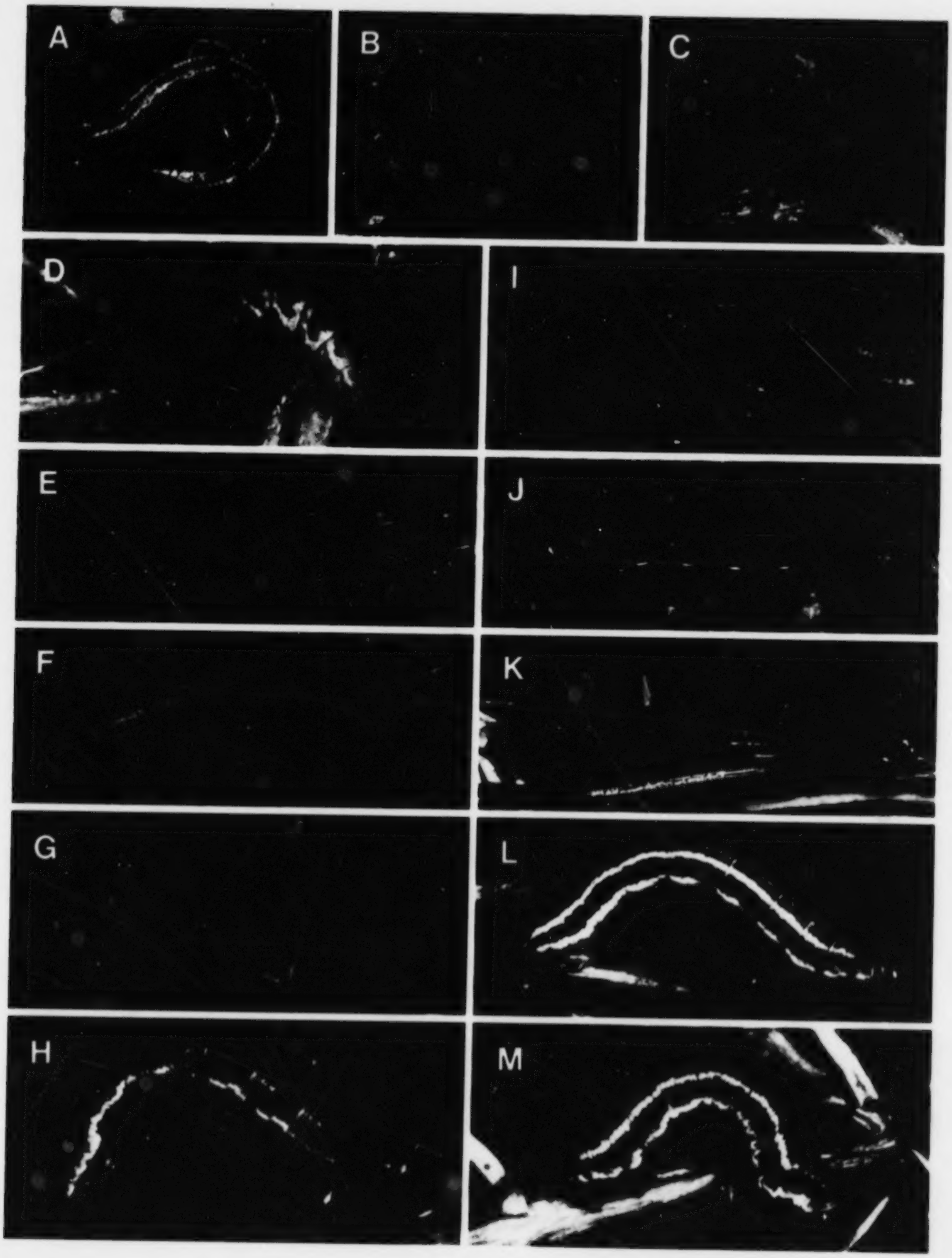
Semiothisa bicolorata larvae (I) have brown heads, green bodies, and reach a length of about 20 mm at maturity. The body has a grayish middorsal stripe and pale yellowish green subdorsal and lateral stripes. ***Semiothisa sexmaculata*** larvae (J) are also green and are marked with whitish and gray-green lines until they reach the last instar, when some of the larvae develop into a brown phase. Mature larvae are about 18 mm long. The green phase closely resembles *S. bicolorata* but can be separated on the basis of host. The brown phase has a dark herringbone pattern on the head (K). It also has a dark herringbone pattern on the body, with a broken black middorsal line. They resemble the dotted line looper, *Protoboarmia porcelaria indicataria* (Walker), (Fig. 12), but the middorsal broken line is less prominent, while the herringbone patterns on the head and body are more so.

Damage

The small amount of defoliation caused by these insects in the prairie provinces has no adverse effect on their hosts, and none are likely to become a problem in this region.

Bibliography: 139, 203, 242, 376, 377, 382, 388, 422, 457, 474, 475, 477

Figure 10. The false hemlock looper, *Nepytia canosaria* (Walker), and some of its allies. **A.** *N. canosaria* larva, brown phase. **B.** *N. canosaria* larva, green phase. **C.** *N. umbrosaria nigrovenaria* (Packard) larva. **D.** *Semiothisa setonana* (McDunnough) larva. **E.** Spruce-fir looper, *S. signaria dispuncta* (Walker), on Douglas-fir. **F.** *S. signaria dispuncta* larva on balsam fir. **G.** Owen's larch looper, *S. oweni* (Swett), brown phase. **H.** *S. oweni* larva, green phase. **I.** Jack pine looper, *S. bicolorata* (Fabricius). **J.** Green larch looper, *S. sexmaculata* (Packard), green phase. **K.** *S. sexmaculata* larva, brown phase.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THE SMALL PINE LOOPER AND ITS ALLIES (Figure 11)

Distribution, Hosts, and Importance

The small pine looper, ***Eupithecia palpata*** Packard, feeds on pine, spruce, balsam fir, and occasionally tamarack. ***Eupithecia fletcherata*** Taylor attacks tamarack and white spruce, and ***E. pusillata interruptofasciata*** Packard feeds on common juniper. The early brown looper, ***E. filmata*** Pearsall, the small conifer looper, ***E. transcanadata*** MacKay, and the fir needle inchworm, ***E. luteata*** Packard, all feed on a wide variety of conifers, particularly spruce, balsam fir, and tamarack. All six species occur in the three prairie provinces.

Eupithecia maestosa (Hulst) and ***E. subfuscata*** (Haworth) were both collected on tamarack in central Saskatchewan but usually feed on hardwood hosts. ***Eupithecia gibsonata*** Taylor feeds on white cedar in southeastern Manitoba. ***Eupithecia annulata*** (Hulst) feeds primarily on Douglas-fir in southwestern Alberta.

The gray pine looper, ***Anacamptodes vellivolata*** (Hulst), occurs as far west as central Saskatchewan and attacks mainly pine, spruce, and tamarack. The transverse banded looper, ***Hydriomena divisaria*** (Walker), occurs throughout most of Canada and feeds primarily on spruce, balsam fir, and tamarack. ***Thera otisi*** (Dyar) and ***T. contractata*** (Packard) feed on common juniper in Alberta and Manitoba, respectively.

None of the above species are of economic importance, although both *T. contractata* and *T. otisi* are potential pests of juniper in ornamental plantings.

Life Cycle and Appearance

Adult *Eupithecia* are mostly small-to-medium sized, dull-colored moths. There is usually one generation per year. Early feeders overwinter in the egg stage, and mid to late season feeders overwinter as pupae.

The larvae of *Eupithecia* are slender, and their heads and bodies are covered with granules. There is a large amount of color variation, both between and within species, and the larvae usually do not exceed 20 mm in length at maturity. ***Eupithecia palpata*** larvae (A) have yellowish to brownish orange heads and bodies. The middorsal line is gray, the subdorsal line is reddish gray and is enlarged at intervals to form patches, and there are two lateral lines. The upper is usually yellow, and the lower may be orange or gray. ***Eupithecia maestosa*** larvae (B) have pinkish gray heads and bodies with few markings except for a dark gray middorsal line. ***Eupithecia fletcherata*** larvae (D) vary in color from yellowish brown to brown. The middorsal line is gray or dark brown and is paired on the thorax but enlarges to form diamond-shaped patches on the abdomen. The dark brown lateral stripe subtends alternating oblique light and dark patches along the sides. ***Eupithecia subfuscata*** larvae (E) are almost identical to those of *E. fletcherata*.

Eupithecia luteata larvae (F) have dull yellow to grayish brown heads. The middorsal line is gray to purplish gray, and the subdorsal line may vary from yellow or orange (G) to gray (F). The lateral line is faint and brown, and the midventral line is also brown. ***Eupithecia filmata*** larvae (not shown) are almost identical to those of *E. luteata* but have a fine red midventral line and feed early in the season; *E. luteata* occur later in the summer. ***Eupithecia pusillata interruptofasciata*** (H) is another early season species. The head and body are green. The middorsal line is gray-green, and the subdorsal and lateral lines are white. ***Eupithecia annulata*** larvae (I) have a light brown head and a yellowish brown or reddish brown body. The middorsal line is brown, expanding into irregular dark patches at intervals, and there is an indistinct cream-colored lateral line. ***Eupithecia gibsonata*** larvae (J) have smooth pea green heads and slightly roughened green bodies. The middorsal line is indistinct and bluish green. The subdorsal line is yellow with an irregular gray spot in the middle of each abdominal segment. The lateral line is alternately white and gray.

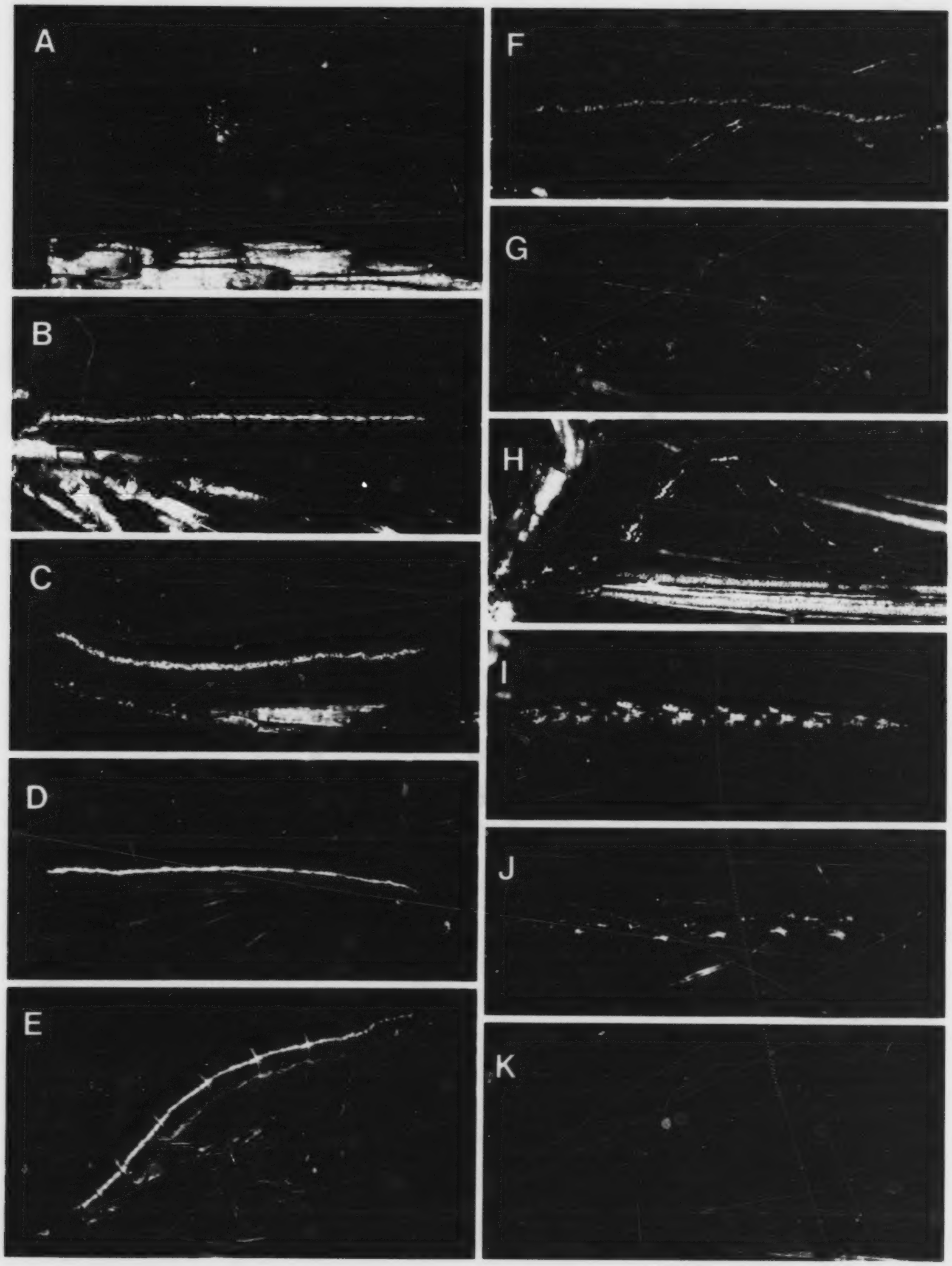
Anacamptodes vellivolata and *H. divisaria* each have one generation per year, overwintering in the pupal stage. Fully grown ***A. vellivolata*** larvae (C) are 20–30 mm long and have brownish bodies that are heavily mottled and striped with purple. Dorsal and lateral setae are borne on prominent tubercles. ***Hydriomena divisaria*** larvae (K) have smooth, light brown heads and dirty-white bodies marbled with gray and are less than 20 mm long when mature. The middorsal and subdorsal lines are connected by dark gray transverse patches which give the larvae a banded appearance. *Thera otisi* and *T. contractata* each have one generation per year, overwintering in the egg stage. ***Thera otisi*** larvae (L) have russet heads, green bodies, and are less than 20 mm long at maturity. The subdorsal and lateral lines are white. The latter usually has a red line above it when the larvae are mature. ***Thera contractata*** larvae (M) are almost identical but do not have the red line at maturity.

Damage

None of these insects cause appreciable damage to their hosts, although ***T. otisi*** and ***T. contractata*** may cause unsightly brown foliage on ornamental junipers.

Bibliography: 139, 349, 375, 379, 384, 389, 457, 474, 475, 477

Figure 11. The small pine looper, *Eupithecia palpata* Packard, and its allies. A. *E. palpata* larva. **B.** *E. maestosa* (Hulst) larva. **C.** Gray pine looper, *Anacamptodes vellivolata* (Hulst). **D.** *E. fletcherata* Taylor prepupa. **E.** *E. subfuscata* (Haworth) larva. **F.** Dorsal view of the fir needle inchworm, *E. luteata* Packard. **G.** Lateral view of *E. luteata*. **H.** *E. pusillata interruptofasciata* Packard larva. **I.** *E. annulata* (Hulst) larva. **J.** *E. gibsonata* Taylor larva. **K.** Transverse-banded looper, *Hydriomena divisaria* (Walker). **L.** *Thera otisi* (Dyar) larva. **M.** *T. contractata* (Packard) larva.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THE PINE LOOPER AND ITS ALLIES (Figure 12)

Distribution, Hosts, and Importance

The pine looper, ***Hypagyrtis piniata*** (Packard), the gray spruce looper, ***Caripeta divisata*** Walker, the green balsam looper, ***Cladara limitaria*** (Walker), the dotted line looper, ***Protoboarmia porcelaria indicataria*** (Walker), and the saddleback looper, ***Ectropis crepuscularia*** (Dyar & Shannon), occur throughout the region and feed mainly on balsam fir, Douglas-fir, tamarack, and white spruce. The last two species also feed on hardwoods. The hemlock looper, ***Lambdina fiscellaria*** (Guenée), ranges west to Alberta and feeds on balsam fir, spruce, tamarack, and hardwoods. The brown pine looper, ***Caripeta angustiorata*** Walker, feeds mainly on lodgepole pine and jack pine.

Dysstroma walkerata (Pearsall) attacks tamarack. ***Eufidonia convergaria*** (Walker) feeds on pine, ***E. notataria*** (Walker) attacks spruce, balsam fir, and tamarack in southeastern Manitoba, and ***E. discospilata*** (Walker) usually feeds on a wide variety of bog plants but has been collected on tamarack in southeastern Manitoba.

Some of the above insects are occasionally quite common in the prairie provinces, but none are of economic importance in this region.

Life Cycle and Appearance

All of these insects have one generation per year, and most of them overwinter in the pupal stage. The adults are usually dull colored, small- to medium-sized moths, and most of the larvae have rough skins and are 20–25 mm long when mature.

Hypagyrtis piniata overwinters as larvae (A) that have pale yellow heads and bodies. The head is heavily marked with brown spots except for a rectangular unmarked area in the middle of the face. The paired middorsal lines are black and expand to enclose diamond-shaped areas on each abdominal segment. There are dark oblique markings on the sides of the last thoracic segment and on each abdominal segment.

The green larvae shown here (B–F) are difficult to identify. ***Eufidonia convergaria*** larvae (B) have a partially paired gray-green middorsal line, a yellowish green subdorsal line, and a prominent white lateral line. They resemble *Semiothisa bicolorata* (Fabricius) larvae (Fig. 10), which also feed on pine, but the brown herringbone pattern on the head is less prominent. ***Eufidonia notataria*** larvae (C) are almost identical to those of *E. convergaria* but are found only in southeastern Manitoba on spruce, balsam fir, and tamarack. They resemble ***Cladara limitaria*** larvae (F), which feed on the same hosts, but the latter have the anal plate edged in yellow; *E. convergaria* do not. ***Eufidonia discospilata*** larvae (D) collected on tamarack resemble the other two members of the genus, but the green was a lighter shade. ***Dysstroma walkerata*** overwinters as second-instar larvae, which start feeding as soon as the foliage flushes. The larvae (E) have green heads and bodies, a white subdorsal line, and a white or cream-colored lateral line.

Ectropis crepuscularia larvae (G) are brown or reddish brown at maturity and reach a length of about 30 mm. The head is mottled and has an inverted V-shaped suture on the face. There is a pair of dorsal tubercles near the rear of the abdomen. ***Lambdina fiscellaria*** overwinters in the egg stage. The buff-colored moths have a wingspan of about 30–40 mm and have two irregular brown bands across each wing. The larvae (H) are extremely variable in coloration. Fully grown larvae are about 30 mm long, and the head and body are greenish gray or gray and are heavily marked with black spots and lines.

Protoboarmia porcelaria indicataria overwinters as late-instar larvae (I). The head and body may be dirty white to dark gray, and the well-defined dark gray middorsal line is present only on the front half of each abdominal segment. The dorsal herringbone pattern on the abdomen is reversed from that on the brown phase of *Semiothisa sexmaculata* (Packard) (Fig. 10), and there are lateral tubercles on the first five abdominal segments of *P. porcelaria indicataria*.

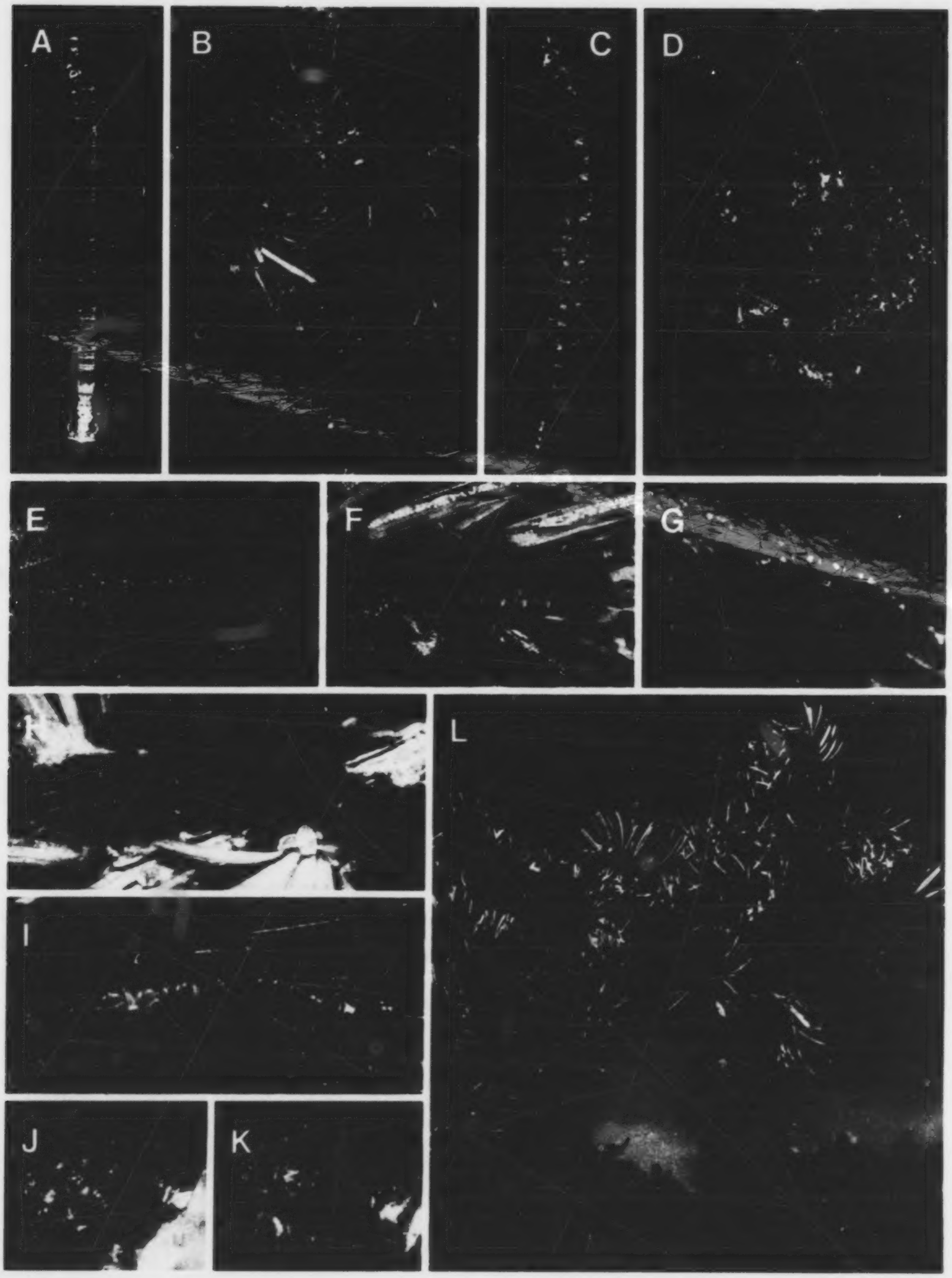
Caripeta divisata adults are light brown with dark brown and white markings. The larvae (J) have smooth skins and reach a length of about 35 mm when mature. The ground color of the head and body varies from yellow to light brown, and most abdominal segments have conspicuous dorsal tubercles. The paired brown middorsal lines delineate a series of diamond-shaped markings on the abdomen, and there are oblique dark markings on the sides of the abdomen. The larvae therefore resemble those of *H. piniata* (A), but the latter lack tubercles. The light-colored elongate markings on the upper part of the head separate *C. divisata* larvae from those of *Anacamptodes vellivolata* (Hulst) (Fig. 11), which also have tubercles. ***Caripeta angustiorata*** adults are rust with dark brown and white markings. The larvae (K) resemble *C. divisata* larvae in all respects except color. The background color is similar, but the markings are less pronounced.

Damage

None of these insects have caused any significant damage in the prairie provinces.

Bibliography: 139, 376, 377, 380, 381, 384, 389, 457, 477

Figure 12. The pine looper, *Hypagyrtis piniata* (Packard), and its allies. A. *H. piniata* larva. **B.** *Eufidonia convergaria* (Walker) larva. **C.** *E. notataria* (Walker) larva. **D.** *E. discospilata* (Walker) larva. **E.** *Dysstroma walkerata* (Pearsall) larva. **F.** Green balsam looper, *Cladara limitaria* (Walker). **G.** Saddleback looper, *Ectropis crepuscularia* (Dyar & Shannon). **H.** Hemlock looper, *Lambdina fiscellaria* (Guenée). **I.** Dotted line looper, *Protoboarmia porcelaria indicataria* (Walker). **J.** Gray spruce looper, *Caripeta divisata* Walker. **K.** Brown pine looper, *C. angustiorata* Walker.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THE PINE WEBWORM AND ITS ALLIES (Figure 13)

Distribution, Hosts, and Importance

The pine webworm, ***Tetralopha robustella*** Zeller, attacks jack pine, Scots pine, and red pine in southeastern Manitoba. ***Dioryctria banksiella*** Mutuura, Munroe & Ross attacks rust galls on jack pine. The spruce coneworm, ***Dioryctria reniculelloides*** Mutuura & Munroe, is a damaging cone-feeding insect (Fig. 3), but it also feeds on the foliage of spruce and balsam fir.

The redstriped needleworm, ***Epinotia radicana*** (Heinrich), feeds on white spruce, Douglas-fir, balsam fir, and other conifers. ***Zeiraphera unfortunana*** Powell was collected on white spruce in Alberta but probably occurs throughout the region. The spruce budmoth, ***Z. canadensis*** Mutuura & Freeman, attacks white spruce, Douglas-fir, balsam fir, and other conifers. The larch budmoth, ***Z. improbana*** (Walker), feeds primarily on tamarack. The spring spruce needle moth, ***Archips packardiana*** (Fernald), attacks spruce, balsam fir, and other conifers. The fall spruce needle moth, ***Argyrotaenia occultana*** Freeman, attacks spruce, lodgepole pine, balsam fir, and tamarack.

All of these insects occur throughout the region unless otherwise noted. The foliage feeding of *D. reniculelloides* is of little concern, but the species is important because it attacks the cones. *Zeiraphera canadensis* has recently been abundant in Alberta but so far is of little economic importance.

Life Cycle and Appearance

All of these insects have one generation per year in the prairie provinces. ***Tetralopha robustella*** overwinters as pupae in cells formed in the soil. The black and gray moths emerge during the summer and have a wingspan of about 25 mm. Eggs are deposited on the needles, and the young larvae mine the needles. Older larvae (A) live in silk tubes within masses of silk and frass (B), and several larvae may inhabit the same mass. Mature larvae are about 18 mm long and have yellowish brown heads and thoracic shields with brown or dark brown markings. The body is yellowish brown with brown or dark brown stripes. ***Dioryctria banksiella*** overwinters as larvae in burrows in the heartwood of the galls. The larvae (C) have reddish brown heads and dark brown thoracic shields with two light patches near the front. The body is greenish gray suffused with purple and lacks conspicuous markings. Frass is expelled from the galls (D), and the pupae protrude from the surface prior to adult emergence. Active galls often bleed profusely (Fig. 41). The gray moths have wingspans of 28–33 mm. ***Dioryctria reniculelloides*** adults (Fig. 3) are similar to those of *D. banksiella*. The insect overwinters as tiny larvae in silken hibernacula. In the spring, the young larvae feed in the cones or elongating buds. Mature larvae (Fig. 3) are about 20 mm long, have dark brown heads, reddish brown thoracic shields, and pale yellow bodies. The middorsal and bordering lines are reddish brown, and the dark paired broken subdorsal lines enclose small patches of yellow for most of the body length.

Epinotia radicana and the three *Zeiraphera* species probably all overwinter in the egg stage. The adults have a wingspan of about 13 mm, and the fore wings are mottled white and brown. Mature larvae are 9–10 mm long. ***Epinotia radicana*** larvae (E) have brown heads, light brown thoracic shields, and yellowish bodies. The indistinct middorsal and subdorsal lines are reddish. The larvae of the spruce-feeding *Zeiraphera* species feed mainly under the bud scales. ***Zeiraphera unfortunana*** larvae (F) have dark brown heads, black thoracic shields, and purplish bodies with broad yellowish subdorsal lines. ***Zeiraphera canadensis*** larvae (G) have yellowish to dark brown heads and thoracic shields and yellowish bodies. The small, dark setal bases are characteristic. Mature ***Z. improbana*** larvae (H) have dusky heads and bodies and feed within webbed needles.

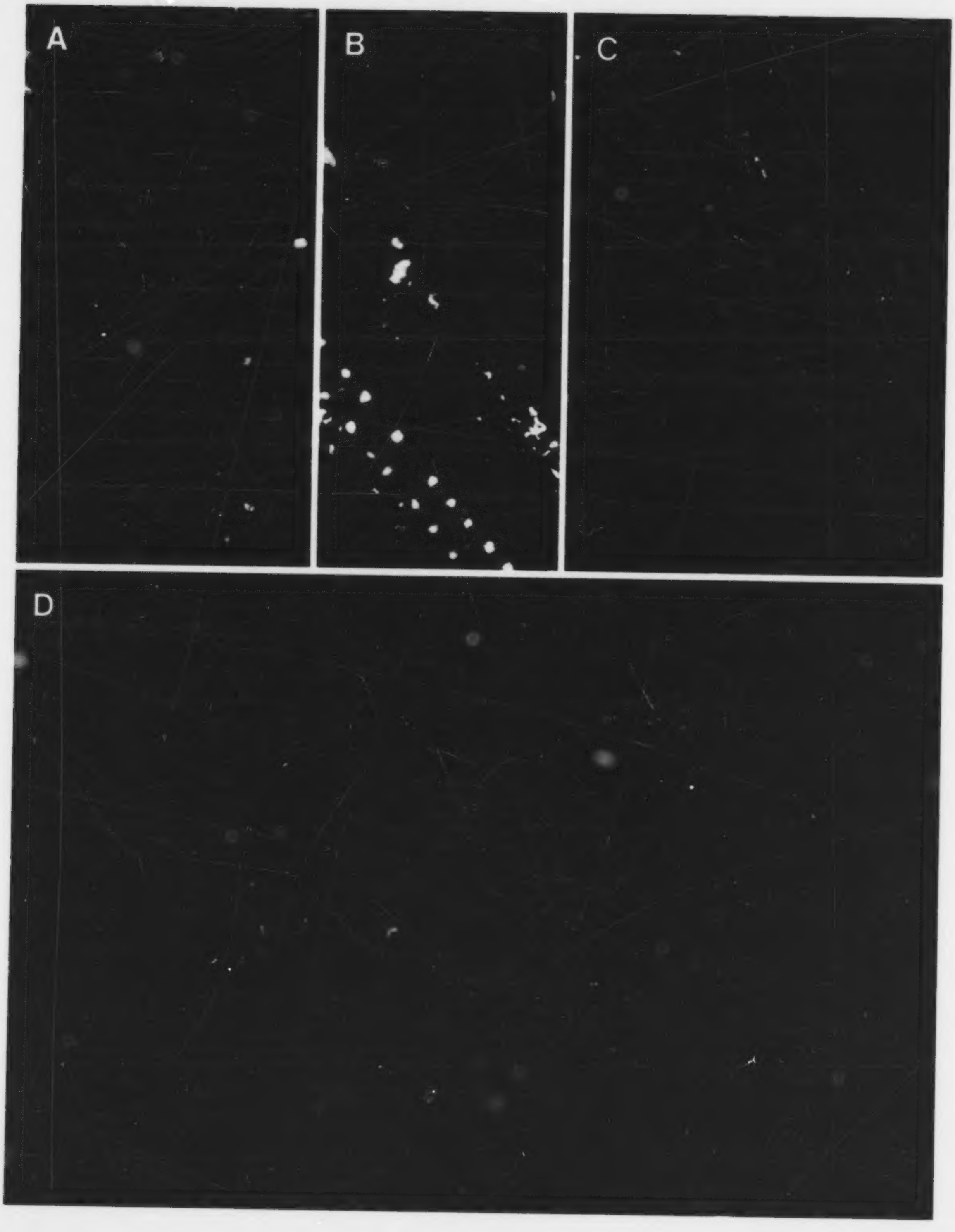
Archips packardiana overwinters as young larvae in mined needles. The adults have mottled white, brown, and black fore wings and have a wingspan of 15–22 mm. The larvae spin a considerable amount of webbing while feeding, and mature larvae (I) are about 20 mm long. Their heads are greenish with black or brown markings that may consist of several fingerlike marks extending toward the face (I) or a single dark bar with a dot in front of it (J). The thoracic shields are green or green with varying amounts of black, and their bodies are yellowish green. ***Argyrotaenia occultana*** probably overwinters as pupae in the soil. The adults also have mottled white, brown, and black fore wings and have a wingspan of 17–19 mm. Mature larvae are 13–16 mm long and resemble *A. packardiana* larvae that have the fingerlike markings, but the dark markings on the heads of *A. occultana* larvae are fragmented (K).

Damage

The defoliation caused by ***D. reniculelloides*** and ***Z. canadensis*** is often associated with that of the spruce budworm, *Choristoneura fumiferana* (Clemens). *Zeiraphera canadensis* feeding damage (L) resembles spruce budworm damage and has been confused with it, but less foliage is destroyed. The feeding of these insects has little effect on the vigor of their hosts, but *D. reniculelloides* is a major seed and cone insect.

Bibliography: 6, 68, 139, 193, 348, 351, 352, 368, 425, 428, 448, 458, 477, 636

Figure 13. The pine webworm, *Tetralopha robustella* Zeller, and its allies. A. *T. robustella* larva. **B.** *T. robustella* webbing and frass. **C.** *Dioryctria banksiella* Mutuura, Munroe & Ross larva. **D.** *D. banksiella* feeding on inactive gall caused by the western gall rust. **E.** Redstriped needleworm, *Epinotia radicana* (Heinrich). **F.** *Zeiraphera unfortunana* Powell larva. **G.** Spruce budmoth, *Z. canadensis* Mutuura & Freeman, larva. **H.** Larch budmoth, *Z. improbana* (Walker), larva. **I.** Spring spruce needle moth, *Archips packardiana* (Fernald), larva. **J.** Close-up of head of dried *A. packardiana* larva showing alternate markings. **K.** Close-up of head of dried fall spruce needle moth, *Argyrotaenia occultana* Freeman, larva showing typical markings. **L.** *Z. canadensis* feeding damage.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THE SPRUCE SPIDER MITE (Figure 14)

Distribution, Hosts, and Importance

The spruce spider mite, ***Oligonychus ununguis*** (Jacobi), has a widespread distribution in the northern hemisphere. In the prairie provinces it is most common in the aspen parkland areas. Although it occurs in forested areas, it is primarily a pest of open-growing planted trees and seems to be especially troublesome during hot, dry weather. The primary hosts of this pest are spruces, but it sometimes attacks balsam fir, Douglas-fir, eastern white cedar, and juniper.

Life Cycle and Appearance

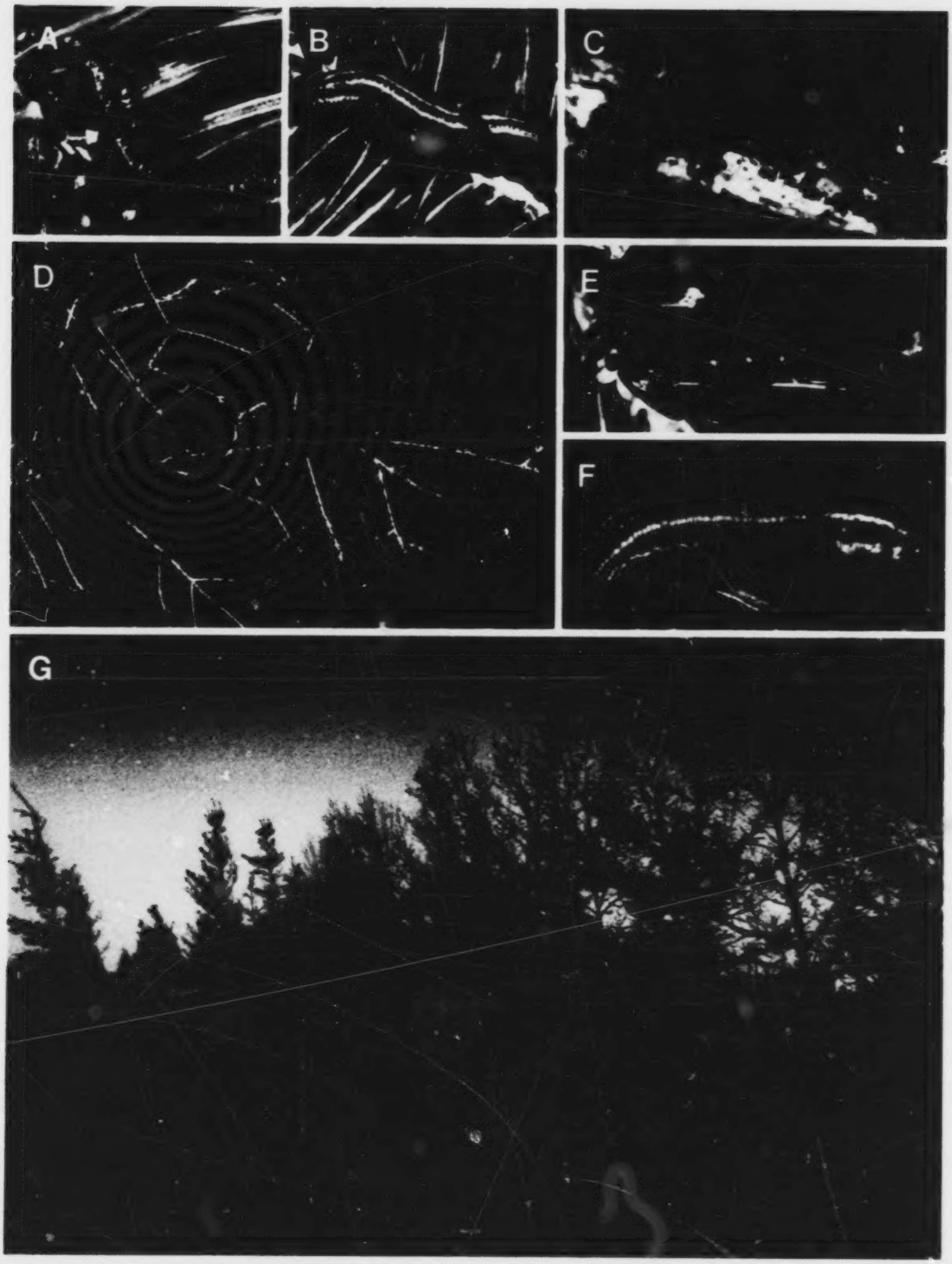
Oligonychus ununguis has several generations per year and overwinters in the egg stage (A) on the host tree. The overwintering eggs hatch in May or early June depending upon the weather, and the young larvae start feeding by sucking sap from the needles and young shoots. The newly hatched larvae are pinkish but change to green after they have fed on the foliage. They are oval in shape and have three pairs of legs. The larvae feed for about 3 days and then molt to the nymphal stage, which resembles the larval stage except that the nymphs are larger and have four pairs of legs. Young nymphs are light green, but they become dark green in the second nymphal instar. After feeding for about 6 days, the nymphs transform into adults, which are similar to the late-instar nymphs but are larger. Color varies from dark green (B) to dark brown. Females are about 0.5 mm long and are larger than the males. They are therefore difficult to see except under magnification. The mites spin webbing wherever they go (C), and their feeding causes discoloration of the foliage (C, D). Both of these symptoms are indicative of mite damage, but checking the foliage with a hand lens or tapping the branches over a sheet of white paper are the best methods for confirming the presence of mites. The mites can be seen with the naked eye as minute moving dots on the white paper. Each female may live for about 1 month and is capable of laying 40–50 eggs. These eggs develop into adults in 2–3 weeks depending upon the weather, and six or more generations may occur during the summer. Hot, dry conditions appear to favor survival, and tremendously high populations may build up by late summer. Deposition of overwintering eggs starts in early September and continues until a hard frost occurs.

Damage

The mites weaken the trees by sucking the sap from the foliage, often causing it to desiccate and drop prematurely. This insidious damage often goes unnoticed, and the tree may be seriously weakened before the problem is recognized. The premature loss of foliage may kill twigs, especially in shaded areas, and may lead to the death of entire branches if the infestation persists. Extremely severe infestations may ultimately kill the trees, especially during periods of drought.

Bibliography: 53, 139, 297, 445, 477

Figure 14. The spruce spider mite, *Oligonychus ununguis* (Jacobi). A. Eggs of *O. ununguis* on white spruce shoot. **B.** Adult *O. ununguis*. **C.** White spruce twig severely infested with *O. ununguis*. **D.** Relative appearance of healthy (left) and *O. ununguis* infested (right) white spruce foliage.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SPRUCE SAWFLIES (Figure 15)

Distribution, Hosts, and Importance

Five species of sawflies attack spruces in the prairie provinces. The most serious pest is the yellowheaded spruce sawfly, ***Pikonema alaskensis*** (Rohwer). It attacks open-grown Engelmann, white, black, and blue spruce and is primarily a pest of ornamental and shelterbelt plantings. The greenheaded spruce sawfly, ***P. dimmockii*** (Cresson), is often found with *P. alaskensis* but is not as common and usually is of minor importance. The little spruce sawfly, ***Pristiphora lena*** Kincaid, occurs in low numbers on white spruce. The balsam fir sawfly, ***Neodiprion abietis*** (Harris) complex, contains a group of closely related races or species. The most important in the prairie provinces attacks white spruce and is primarily a pest of ornamental and shelterbelt plantings. The European spruce sawfly, ***Gilpinia hercyniae*** (Hartig), an introduced species, first spread into southeastern Manitoba in 1969. It has increased in numbers since then and is now more abundant than *P. dimmockii* in some areas.

Life Cycle and Appearance

Pikonema alaskensis has one generation per year and overwinters as larvae in soil-encrusted cocoons beneath the trees. The adults are typical sawflies, emerging from the soil between late May and mid-June. Eggs are deposited singly in the base of the new needles. The larvae at first feed on the new foliage, then move onto the old foliage. They have yellowish brown heads and shiny olive green bodies with paired longitudinal grayish green dorsal and subdorsal lines (A). There is also a single grayish green line below the spiracles. They attain a length of 16–20 mm when fully grown. The life history of ***P. dimmockii*** resembles that of *P. alaskensis*. The larvae have green heads and green bodies with whitish green stripes (B). They are about 20 mm long when fully grown. Little is known about the life history of ***Pristiphora lena***, but it is believed to be similar to that of *Pikonema alaskensis*. Mature larvae (C) resemble *P. alaskensis* larvae but are much smaller, measuring only 10 mm in length when fully grown. The following characteristics of *P. lena* also help to separate the two species. The body is a dull olive green with darker paired dorsal lines. The subdorsal line is broad and not paired, and the line below the spiracles is lacking. Last-instar larvae have yellowish brown heads, but those of young larvae are black.

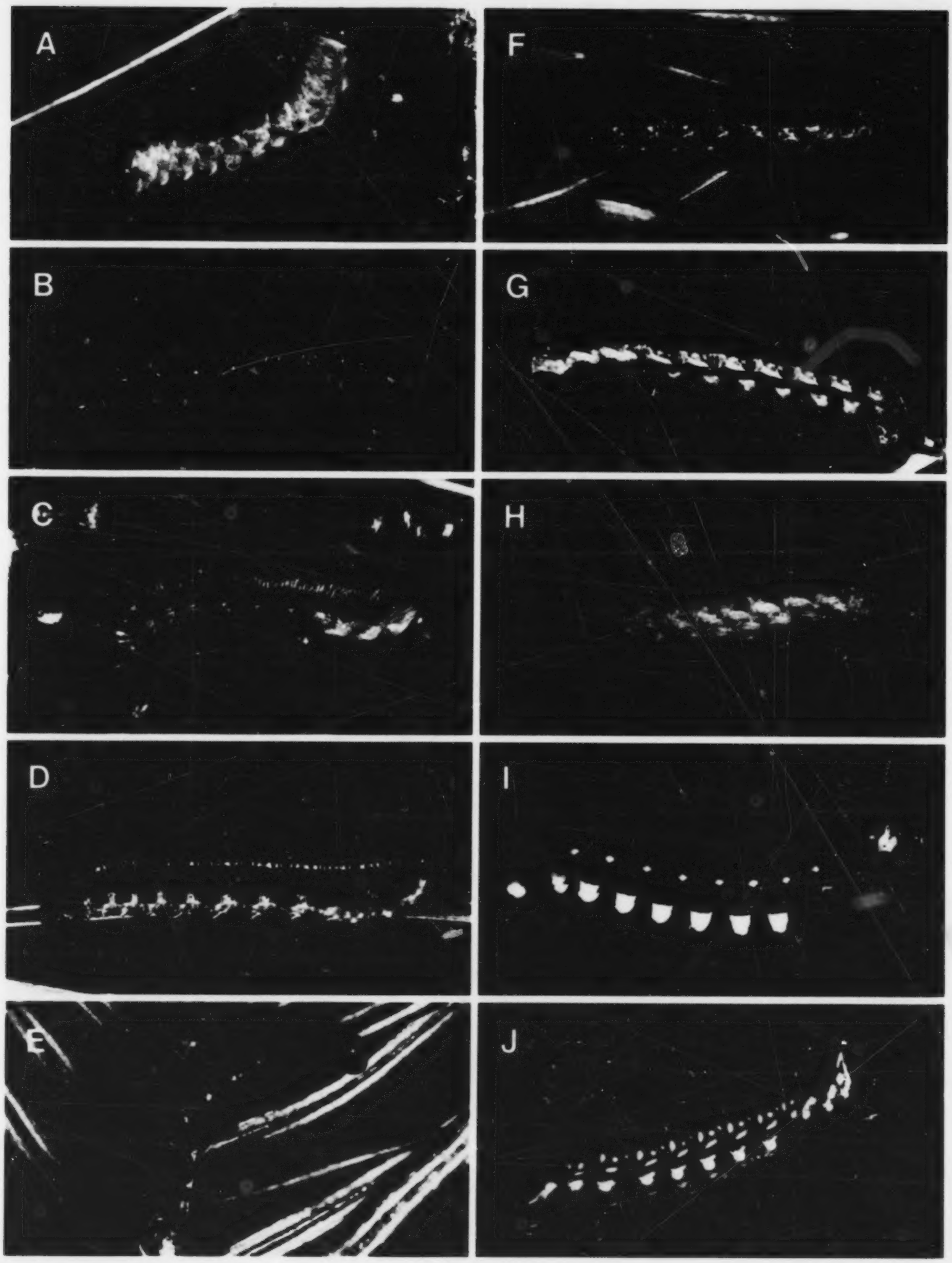
Neodiprion abietis has one generation per year and overwinters in the egg stage. The larvae feed at about the same time as the preceding three species. They normally eat old foliage but will eat new foliage when food is scarce. Young larvae are green with black heads. Older larvae have dark stripes (E) and measure about 20 mm in length when fully grown. Adults emerge in the fall and lay their eggs in slits in the foliage. ***Gilpinia hercyniae*** probably has two generations per year in southeastern Manitoba. Adult females (males are rare and probably nonfunctional) emerge in the spring, laying their eggs on the old foliage. First generation larvae feed on old foliage during June and July. They have yellowish heads and green bodies and reach a length of about 20 mm when fully grown (F). Mature larvae have a dark brown triangular mark on the front of the head and five longitudinal white lines. They drop to the ground when feeding is completed to spin cocoons. Adults emerge about a month later, and the second generation feed during August and September.

Damage

Except for the age of foliage eaten, the feeding damage caused by all five species of spruce sawflies is similar, but only that of ***P. alaskensis*** will be discussed, since it is usually the most damaging. The young larvae eat most of the new foliage before moving onto the old foliage, so that the affected branchlets are almost devoid of foliage (D). During a heavy attack most of the trees' foliage may be devoured (G). Repeated attacks may kill the trees or severely retard both height and radial growth, especially since there is a tendency for the sawflies to concentrate their attacks on trees previously defoliated.

Bibliography: 44, 260, 285, 312, 333, 439, 463, 466, 486, 488, 563, 624, 637, 647

Figure 15. Spruce sawflies. A. Yellowheaded spruce sawfly, *Pikonema alaskensis* (Rohwer), larva. **B.** Greenheaded spruce sawfly, *Pikonema dimmockii* (Cresson), larva. **C.** Little spruce sawfly, *Pristiphora lena* Kincaid, larva. **D.** Close-up of *P. alaskensis* defoliation. **E.** Balsam fir sawfly, *Neodiprion abietis* (Harris) complex, larva. **F.** European spruce sawfly, *Gilpinia hercyniae* (Hartig), larva. **G.** Spruce shelterbelt defoliated by *P. alaskensis* larvae.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NEODIPRION SAWFLIES AND THEIR ALLIES (Figure 16)

Distribution, Hosts, and Importance

Neodiprion sawflies and their allies are potentially serious pests, but all recorded infestations in the prairie provinces have so far been localized and short-lived. The Swaine jack pine sawfly, ***N. swainei*** Middleton, is a major eastern pest whose range extends into Manitoba. Its primary host is jack pine, but it will feed on other pines if infestations are severe. The balsam fir sawfly, ***N. abietis*** (Harris) complex (Fig. 15), attacks white spruce, balsam fir, and Douglas-fir wherever these trees occur naturally. ***Neodiprion*** nr. ***scutellatus*** Rohwer feeds on Douglas-fir. The redheaded jack pine sawfly, ***N. dubiosus*** Schedl, and the brownheaded jack pine sawfly, ***N. rugifrons*** Middleton, both probably attack jack pine wherever it occurs.

Neodiprion abbotii (Leach) and the red pine sawfly, ***N. nanulus nanulus*** Schedl, are eastern species whose ranges extend into Alberta. Both insects will feed on a variety of pines. ***Neodiprion nanulus contortae*** Ross is the western form of the red pine sawfly that feeds on lodgepole pine. ***Neodiprion pratti banksianae*** Rohwer and ***N. maurus*** Rohwer feed on jack pine in Manitoba and Saskatchewan. The European pine sawfly, ***N. sertifer*** (Geoffroy), is an introduced species that has not yet reached the region. The introduced pine sawfly, ***Diprion similis*** (Hartig), is now present in Manitoba. Scots pine is the preferred host for both species.

Life Cycle and Appearance

The adults of these sawflies are nondescript, small (6–10 mm long), yellowish brown to black wasplike insects with four membranous wings. They are difficult for anyone but a specialist to identify. Identification of the larvae on the basis of host and appearance, although tenuous, is probably the most practical method for field identification.

The life histories of most *Neodiprion* species are similar. All have one generation per year. The larvae are gregarious, especially when young. They eat mostly old foliage and reach a length of 18–25 mm when fully grown. Known larvae have an active, nonfeeding prepupal stage before spinning tough leathery cocoons.

Species overwintering in cocoons will be discussed first. Mature ***N. swainei*** larvae have a dark greenish or grayish subdorsal line that is almost continuous. The head is usually orange or dark brown; there is a black divided dorsal anal patch and usually a broken line above the spiracles. All but the dorsal anal patch may be lacking in larvae that are not mature (A). ***Neodiprion rugifrons*** larvae have orange-brown heads and whitish green bodies with conspicuous gray subdorsal lines, black lateral lines, and a dorsal black anal patch. The lateral lines tend to break into spots on mature larvae (C). ***Neodiprion dubiosus*** larvae also have orange-brown heads, but their bodies are yellowish green and the subdorsal lines are a dark grayish green (D).

Neodiprion abbotii larvae resemble those of *N. dubiosus* except for a pale spot on the front of the dark head (F). ***Neodiprion maurus*** larvae (H) have black heads but otherwise resemble those of *N. rugifrons*. ***Neodiprion sertifer*** larvae (I) resemble those of *N. pratti banksianae*, but the basic body color is grayish green, and some of the dark bands tend to break into spots. ***Diprion similis*** has two generations annually. The larvae have black heads and black bodies heavily marked with white and yellow spots (J).

The following species overwinter in the egg stage. ***Neodiprion*** nr. ***scutellatus*** larvae resemble those of *N. dubiosus*, but the broad bands are olive green (B). ***Neodiprion nanulus nanulus*** larvae (G) are almost indistinguishable from those of *N. abbotii* but lack the pale spot on the front of the dark head. ***Neodiprion abietis*** (E) and *N. pratti banksianae* larvae (not shown) have black heads, a yellowish green body, and black subdorsal and lateral stripes.

Damage

Neodiprion sawflies consume primarily old foliage, and consequently even severely defoliated trees are able to withstand several years of repeated defoliation before dying. One or two years of defoliation may be sufficient to kill the affected trees, however, if the trees are simultaneously attacked by an insect that eats the current year's foliage, such as the jack pine budworm.

Bibliography: 13, 25, 26, 27, 103, 139, 203, 255, 302, 367, 368, 396, 474, 488, 577, 585, 617, 622, 623, 625

Figure 16. **Neodiprion sawflies and their allies. A.** Swaine jack pine sawfly, *N. swainei* Middleton, larva. **B.** *N.* nr. *scutellatus* Rohwer larva. **C.** Redheaded jack pine sawfly, *N. rugifrons* Middleton, larva. **D.** Brownheaded jack pine sawfly, *N. dubiosus* Schedl, larva. **E.** Balsam fir sawfly, *N. abietis* (Harris) complex, larva. **F.** *N. abbotii* (Leach) larva. **G.** Red pine sawfly, *N. nanulus nanulus* Schedl, larva. **H.** *N. maurus* Rohwer larva. **I.** European pine sawfly, *N. sertifer* (Geoffroy), larva.* **J.** Introduced pine sawfly, *Diprion similis* (Hartig), larva.

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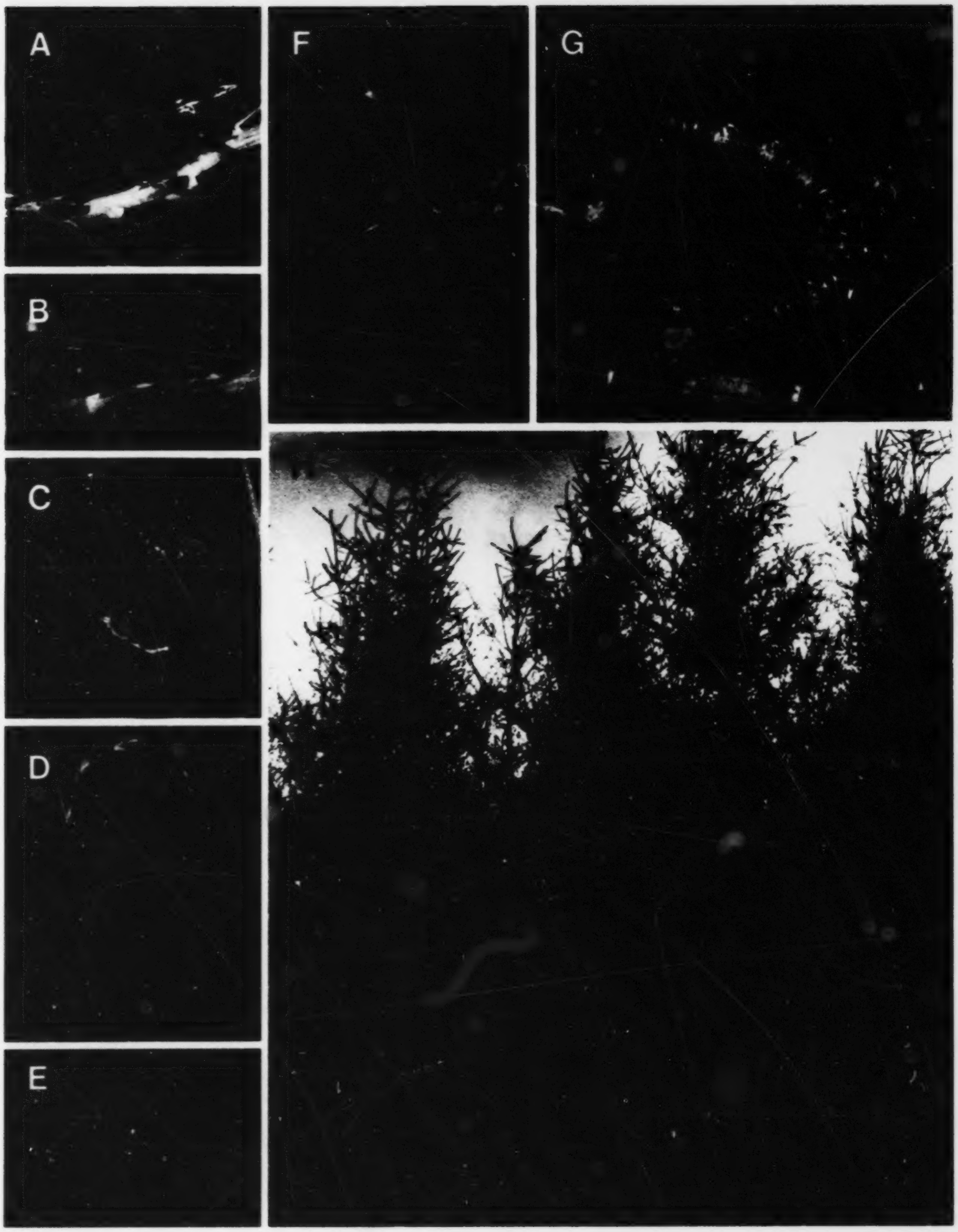
* Photograph courtesy of Great Lakes Forestry Centre.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THE LARCH SAWFLY (Figure 17)

Distribution, Hosts, and Importance

The larch sawfly, ***Pristiphora erichsonii*** (Hartig), is believed by some entomologists to be an introduced insect in North America, while others believe that it migrated to this continent via the Bering Land Bridge during the middle Miocene. The larch sawfly attacks tamarack and other larches. Outbreaks in eastern Canada in the late 19th century were particularly devastating. It has been credited with killing most of the merchantable tamarack in this country. Outbreaks in regeneration tamarack stands have occurred at relatively frequent intervals until quite recently. A parasite (*Olesicampe benefactor* Hinz) was introduced into Manitoba from Europe in 1961 and has since been redistributed to several other areas in Canada. It appears to be controlling the larch sawfly at present in the release areas. Localized infestations have been noted recently in the prairie provinces, but these have not been near any of the release areas.

Life Cycle and Appearance

Pristiphora erichsonii normally has one generation per year; occasionally there is a partial second generation. Females lay viable eggs without mating. A small percentage of males occurs, but it is not known if they mate. The larch sawfly overwinters as a larva in a tough leathery cocoon spun in moss or duff. During wet weather the larvae will spin cocoons near the surface, but during dry spells the larvae burrow down to find moisture before spinning cocoons. Cocoons spun by male larvae and by females containing the newly introduced parasite are noticeably smaller than those spun by unparasitized female larvae (E). Adults emerge from cocoons over a prolonged period beginning in late May or early June; consequently, some larvae complete development before the last adults have emerged. The female is about 10 mm long and is predominantly black with an orange band around the abdomen and orange or yellowish markings on the legs (A). The eggs are laid in slits cut into the elongating shoot by the female's ovipositor, which usually causes the shoot to curl (D). The eggs are completely hidden when first laid, but after imbibing moisture they swell, showing their glistening surfaces (B). Larvae have three pairs of thoracic legs and seven pairs of abdominal prolegs. The young larvae are pale green with brownish or black heads (C). They cut notches in the sides of the needles at first, but soon eat the whole needle. The larvae are gregarious and feed in colonies, especially during the early instars (F). The colonies tend to mingle or break up as the larvae grow older, particularly during severe infestations, and it is not unusual to find older larvae feeding in small colonies or individually. Mature larvae are about 16 mm long and have black heads (G). The upper part of the body is grayish green, and the lower part is lighter green. The period required for individual larvae to complete their feeding varies with temperature but usually ranges from 3 to 4 weeks.

Damage

Moderate-to-severe defoliation by ***P. erichsonii*** (H) causes a marked reduction in length of needles and in radial increment the following year. Prolonged defoliation will cause twig and branch mortality and may eventually kill the tree, although the trees can generally withstand a surprising amount of defoliation without succumbing. Even trees that have lost most of their branches may eventually recover if the outbreak subsides and growth conditions are favorable.

Bibliography: 12, 137, 220, 256, 291, 292, 293, 430, 582, 583, 584, 638

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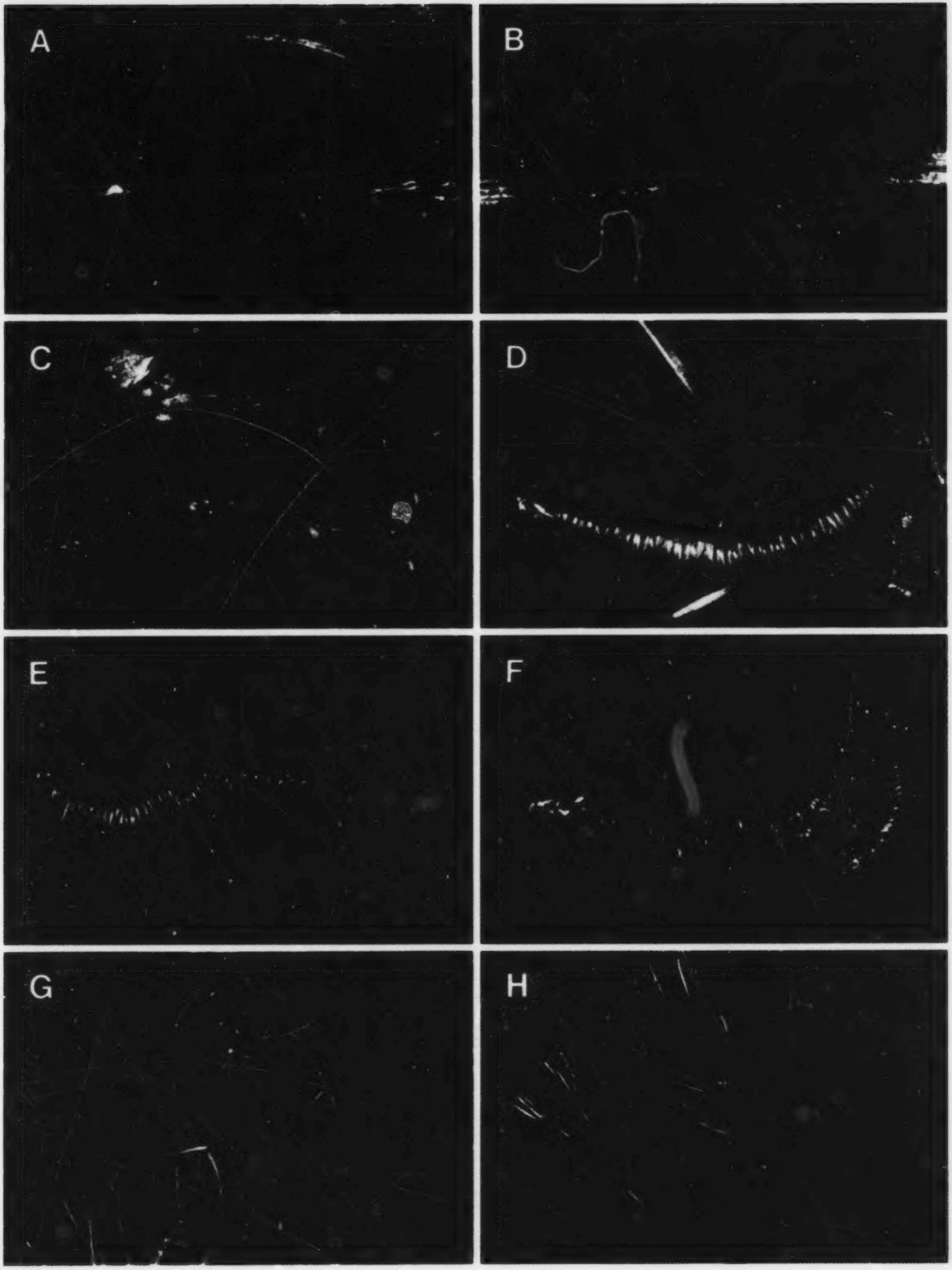
igure 17. The larch sawfly, *Pristiphora erichsonii* (Hartig). A. Female *P. erichsonii*. **B.** Eggs in tamarack shoot. **C.** Newly hatched larvae. **D.** Curled shoot caused by larch sawfly oviposition. **E.** Cocoons. Those on the left are either males or females parasitized by *Olesicampe benefactor* Hinz. The cocoon on the right is a normal-sized female cocoon. **F.** Colony of half-grown larvae. **G.** Mature larva. **H.** Tamarack defoliated by larch sawfly larvae.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MISCELLANEOUS SAWFLIES ON CONIFERS (Figure 18)

Distribution, Hosts, and Importance

Several examples of minor sawflies on conifers are discussed here. The onelined larch sawfly, ***Anoplonyx canadensis*** Harrington, and the threelined larch sawfly, ***A. luteipes*** (Cresson), feed on tamarack throughout the region. ***Monoctenus melliceps*** (Hartig) attacks eastern white cedar and common juniper in southeastern Manitoba.

A solitary pamphiliid, possibly ***Acantholyda* nr. *tesselata*** (Klug), has been collected in southeastern Manitoba on jack pine. Two nest-building pamphiliids, the blue spruce sawfly, ***Cephalcia fascipennis*** (Cresson), and ***C. provancheri*** (Huard), have been collected from blue spruce in central Alberta. Another nest-building pamphiliid, possibly the nesting pine sawfly, ***A. zappei*** (Rohwer), has been collected on eastern white pine in Manitoba.

None of these sawflies are of economic importance in the prairie provinces.

Life Cycle and Appearance

Anoplonyx canadensis has one generation per year and overwinters as prepupae in cocoons spun in the moss. Particles of moss are incorporated into the cocoons, making them difficult to find. The adults are small black sawflies about 5 mm long that emerge from the duff in late May or June. Eggs are laid in the needles. The larvae (A) are solitary feeders, have five instars, and are 8-15 mm long at maturity. They have black or brown heads and green bodies with a lateral dark olive green stripe. Feeding is completed in late August or early September. The life cycle of ***A. luteipes*** is very similar, but the adults emerge earlier in the season and larval feeding is also completed earlier. The adults resemble those of *A. canadensis*. The larvae (B) are also similar, but they have three longitudinal dark olive green lines instead of one. The first is subdorsal, the second is lateral, and the third (not visible in the photograph) is just above the prolegs.

Adult ***Monoctenus*** species are medium-sized sawflies that emerge from the duff in late May or early June. The larvae (C) feed during June and July and are about 18 mm long when mature. They have brown heads with black eye spots. The upper half of the body is dark olive green, and the lower half, including the prolegs, is light green. The thoracic legs are black. The larvae spin cocoons in the duff when feeding is completed and overwinter as prepupae.

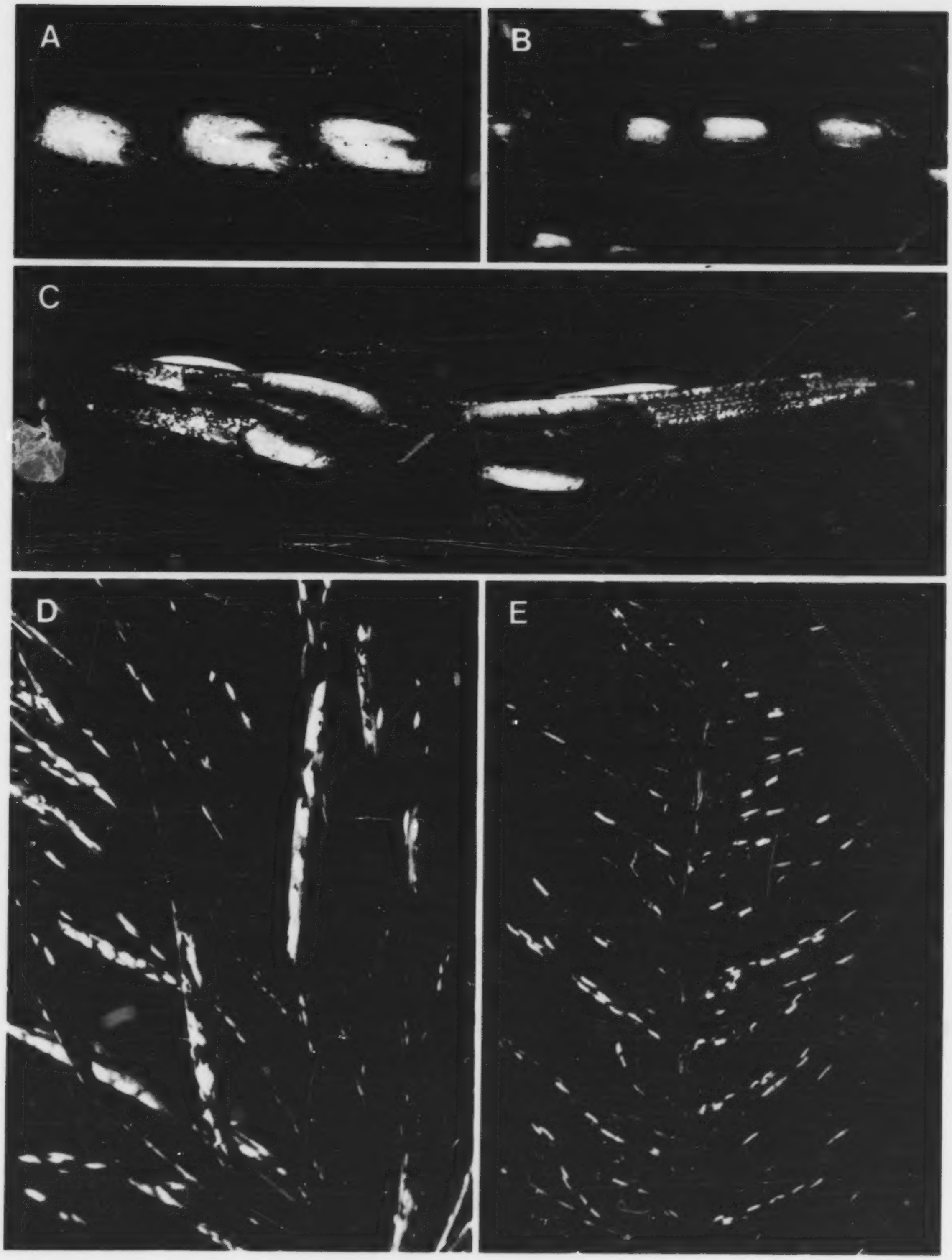
The pamphiliids or web-spinning sawflies have not been studied extensively, and little is known about their life histories or larval taxonomy. All are believed to have one generation per year, overwintering as prepupae in earthen cells in the soil beneath the trees. The adults emerge during the spring or early summer. They are medium-sized, brown or black sawflies with round faces. The larvae have brown or black heads and yellow (E), green (D, F), or reddish bodies. Many change color in the last instar, and all are 22–25 mm long when mature. Most have dark middorsal and lateral stripes or lines. The larvae have functional thoracic legs without claws but have no prolegs, although the eighth abdominal segment has a fleshy appendage that resembles one (F). The most conspicuous features separating pamphiliid larvae from other sawfly larvae, apart from the lack of prolegs, are the long antennae and the lateral appendages on the last abdominal segment. There is also a small, dorsal, caudal hook on the last abdominal segment (D, E). Some larvae, such as the one tentatively identified as ***Acantholyda* nr. *tesselata*** (D), feed solitarily in silk-lined tubes. Other larvae, such as ***C. fascipennis*** (E), ***C. provancheri*** (F), and ***A. zappei*** feed gregariously in a mass of silk, frass, and dead needles (G, H).

Damage

None of these sawflies cause enough defoliation to seriously damage their hosts. The masses of frass and debris (G, H) are very unsightly on ornamentals.

Bibliography: 139, 368, 474, 475, 477, 633

Figure 18. Miscellaneous sawflies on conifers. A. Onelined larch sawfly, *Anoplonyx canadensis* Harrington, larva. **B.** Threelined larch sawfly, *A. luteipes* (Cresson), larva. (The dark line above the prolegs is not visible from this angle.) **C.** *Monoctenus melliceps* (Hartig) larva. **D.** Solitary pine feeding pamphiliid larva, possibly *Acantholyda* nr. *tesselata* (Klug). **E.** Blue spruce sawfly, *Cephalcia fascipennis* (Cresson), larva. **F.** *C. provancheri* (Huard) larva. **G.** Blue spruce damaged by *C. fascipennis* and *C. provancheri* larval feeding. **H.** White pine infested with gregarious pamphiliid larvae, possibly the nesting pine sawfly, *A. zappei* (Rohwer).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THE PINE NEEDLE SCALE (Figure 19)

Distribution, Hosts, and Importance

The pine needle scale, ***Chionaspis pinifoliae*** (Fitch), is primarily a pest of planted conifers in the agricultural areas of the Canadian prairies. White spruce is the preferred host, but blue spruce, pine, and Douglas-fir are also attacked. Moderate-to-severe infestations have occurred on many coniferous plantings in urban areas during the past 50 years, particularly in Manitoba and Saskatchewan. The insect is not usually a major problem in natural forests.

Life Cycle and Appearance

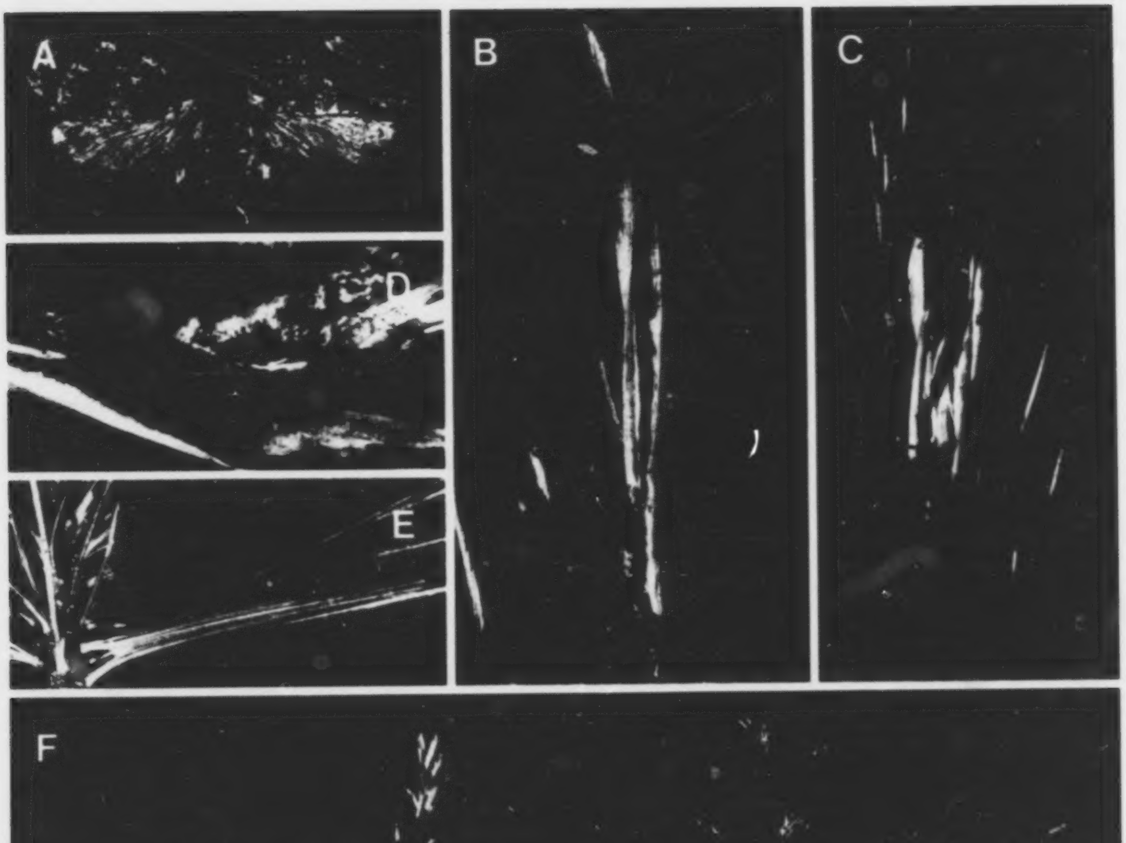
Chionaspis pinifoliae has one generation per year in the prairie provinces. The eggs overwinter beneath the scale secreted by the female (A). The mature female is about 2.5 mm long, and the scale is about 8 mm. Male scales (B) are much smaller (1.0 mm). The eggs hatch in late May or June, depending upon weather conditions. The minute (0.3 mm) reddish crawlers (nymphs) (C) move over the surface of the needles for as long as 3 or 4 days in search of a feeding site. Female crawlers travel an average of 11 cm before settling on the needles, and males wander about 3 cm. Wind is responsible for most of the dispersal of crawlers to uninfested trees. Young scales have been trapped more than 2 km from the nearest source. After settling on the foliage, young crawlers lose their appendages by molting, and protective scales are secreted. Once feeding starts, the nymphs change to a pale yellow color. Females molt again in about 3 weeks to become sexually mature in late July or August. The minute, winged males emerge at this time and search out the females. After mating, the female begins to lay eggs under the scale, gradually shrinking in size as she does so. Egg laying may continue until late October under favorable weather conditions.

Damage

Chionaspis pinifoliae causes a yellowing of the foliage in the area surrounding each scale, and these areas tend to coalesce when the trees are heavily infested (D, E). Consequently, the foliage on severely damaged trees becomes discolored and unhealthy looking, and the waxy white secretions of the scale insects often give the affected trees a grayish appearance. Prolonged infestations on spruce cause the trees to lose most of their needles prematurely and may eventually cause mortality. Infestations on pine cause a marked reduction in the length of the needles and a reduction in the trees' growth rate.

Bibliography: 69, 70, 117, 433, 444

Figure 19. The pine needle scale, *Chionaspis pinifoliae* (Fitch). **A.** Female *C. pinifoliae.* **B.** Male and female scales. Note that male scales are much smaller than the females'. **C.** Old scales and crawlers on needle. **D.** Heavily infested pine foliage. **E.** Heavily infested spruce foliage.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PINE TUBE MOTHS (Figure 20)

Distribution, Hosts, and Importance

Two species of pine tube moths occur in the prairie provinces. The jack pine tube moth, ***Argyrotaenia tabulana*** Freeman, attacks jack pine, lodgepole pine, and whitebark pine. Light-to-moderate infestations have been reported on jack pine in all three provinces, but only one moderate-to-severe outbreak has been noted. This occurred in the early 1960s, when extensive areas of jack pine in northeastern Alberta and northwestern Saskatchewan were attacked. A small pocket of moderate-to-severe defoliation also occurred in the Prince Albert area of Saskatchewan. The pine tube moth, ***A. pinatubana*** (Kearfott), attacks white pine and occurs in small numbers in southeastern Manitoba.

Life Cycle and Appearance

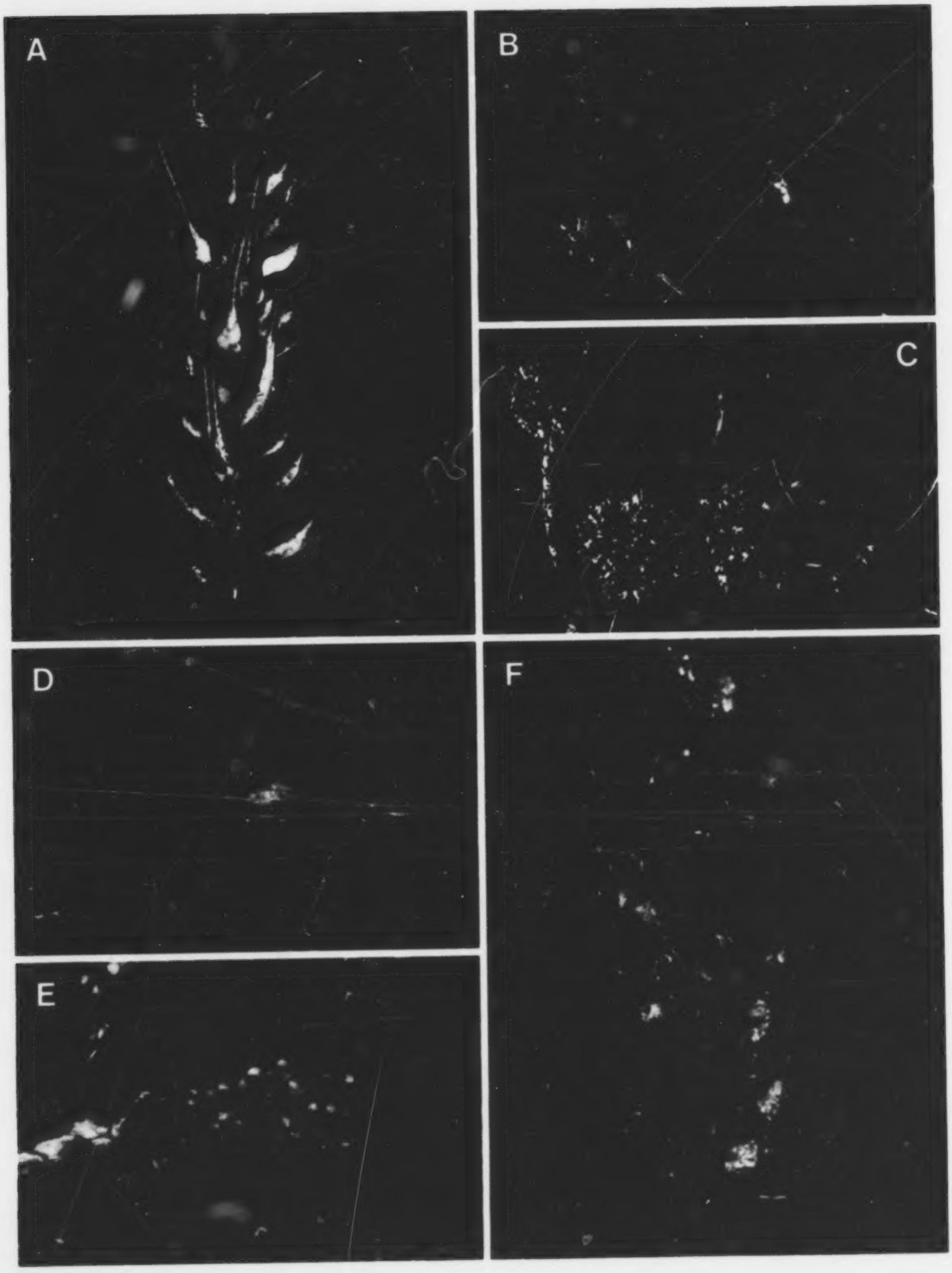
Argyrotaenia tabulana has one generation per year. The adults emerge from the forest litter between late April and early June. They are small brownish-colored moths with a wingspan of 13-17 mm (A). Young larvae mine the needles (B), but as they grow older they tie two or more needles together to form a tube in which they feed, hence the name tube moth (C). The larvae have yellowish brown heads and green bodies (D). The thoracic and anal shields are almost the same color as the rest of the body. The larvae are 13-15 mm long when feeding is completed in late August or early September. The fully fed larvae drop from the trees and pupate in the forest litter, where they overwinter. The life history of ***A. pinatubana*** is very similar. The adults and larvae both resemble those of *A. tabulana* but can be separated on the basis of host, because *A. pinatubana* attacks only white pine (E).

Damage

Feeding by ***A. tabulana*** causes the affected needles to dry out and turn a yellowish brown or reddish brown color (F). Light infestations have very little effect on the growth or survival of the affected trees. Moderate-to-severe attack will cause a severe reduction in annual radial increment and branch and twig mortality. The limited information available indicates that tree mortality may even occur among young trees if the infestation occurs during a period of severe drought. The small numbers of the pine tube moth that have been observed on white pine in Manitoba would have no adverse effect on growth or survival of the affected trees.

Bibliography: 139, 193, 203, 352, 474

Figure 20. Pine tube moths. A. Jack pine tube moth, *Argyrotaenia tabulana* Freeman. **B.** Tube formed by *A. tabulana* larva on jack pine, opened to show larva inside. **C.** Close-up of typical *A. tabulana* damage. **D.** *A. tabulana* larva. **E.** Tube formed by the pine tube moth larva, *A. pinatubana* (Kearfott), on eastern white pine. **F.** Appearance of jack pine severely attacked by *A. tabulana*.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GALLS ON CONIFERS (Figure 21)

Distribution, Hosts, and Importance

Adelgids or woolly aphids (Fig. 24) are probably the most common cause of conspicuous insect galls on conifers, but galls resulting from attack by other insects are occasionally encountered. The introduced false balsam gall midge, ***Dasineura balsamicola*** (Lintner), has reportedly caused gall formation on the needles of balsam fir wherever this tree occurs, but recent studies have shown that the galls are caused by the balsam gall midge, ***Paradiplosis tumifex*** Gagné. *Dasineura balsamicola* is an inquiline that lives in the galls caused by *P. tumifex*. Young balsam fir trees appear to be more severely affected than older trees, so that the pests are of greatest concern in young ornamental plantings or in balsam fir Christmas tree plantations. The spruce gall midge, ***Mayetiola piceae*** (Felt), causes gall formation on the twigs of spruces but is of minor importance. Its range extends from Alberta to the Maritimes.

A small wasp, ***Eurytoma calycis*** Bugbee, occasionally causes gall formation at the bases of jack pine needles. A light infestation was reported on small jack pine trees in Saskatchewan, but the insect is usually not detected because the galls are inconspicuous. Its range probably coincides with that of jack pine. The pine rosette mite, ***Trisetacus gemmavitians*** Styer et al., occasionally causes galls on the twigs of jack pine. Little is known about its distribution, but it probably occurs throughout the region.

Life Cycle and Appearance

Both of the midges associated with the needle galls on balsam fir, ***D. balsamicola*** and ***P. tumifex***, have one generation per year and overwinter as third-instar larvae in the litter. *Dasineura balsamicola* spin cocoons in the soil, but *P. tumifex* apparently do not. Adults of both species emerge in the spring and lay eggs on the needles of expanding balsam fir shoots. *Paradiplosis tumifex* females start to oviposit a few days earlier than those of *D. balsamicola*. The feeding of first-instar *P. tumifex* larvae stimulates the host tissue to grow up around them, forming galls (A). *Dasineura balsamicola* larvae move into these galls to feed and gradually suppress the *P. tumifex* larvae, eventually killing them. Mature *P. tumifex* larvae are yellowish orange in color with a smooth skin and are 1.3-2.8 mm long. Mature *D. balsamicola* larvae are dark orange in color, with a bumpy skin that has darker orange bumps, and are 1.5-3.0 mm long. *Paradiplosis tumifex* larvae drop to the litter in the fall, about 2 weeks sooner than those of *D. balsamicola*.

The life history of ***E. calycis*** has not been studied in detail. There appears to be two generations annually, and the insect overwinters as a last-instar larva in the tissue of the current season's growth. Development is completed in the spring, and the adults emerge soon afterwards. They apparently lay their eggs near the base of the needles, which become swollen to form inconspicuous galls in which the larvae feed (B). Adults from this generation emerge in late July and are believed to lay their eggs near the terminal bud. The larvae enter the shoot and mine the tissue, completing their development by late September.

Although the life history of ***M. piceae*** in the prairie provinces has not been studied, it is believed to be as follows. The midge has one generation per year and overwinters as mature larvae in the galls. Pupation occurs in the spring, and the adults emerge in late May or early June, leaving conspicuous emergence holes (F). The females lay their eggs at the bases of the needles on the new shoots. The larvae bore into the shoot and form a cell, which stimulates gall formation (E). Externally, the galls consist of a series of hemispherical swellings that enlarges the shoot to more than twice its normal diameter. Mature larvae are 1.3-1.7 mm long and are reddish orange in color (D).

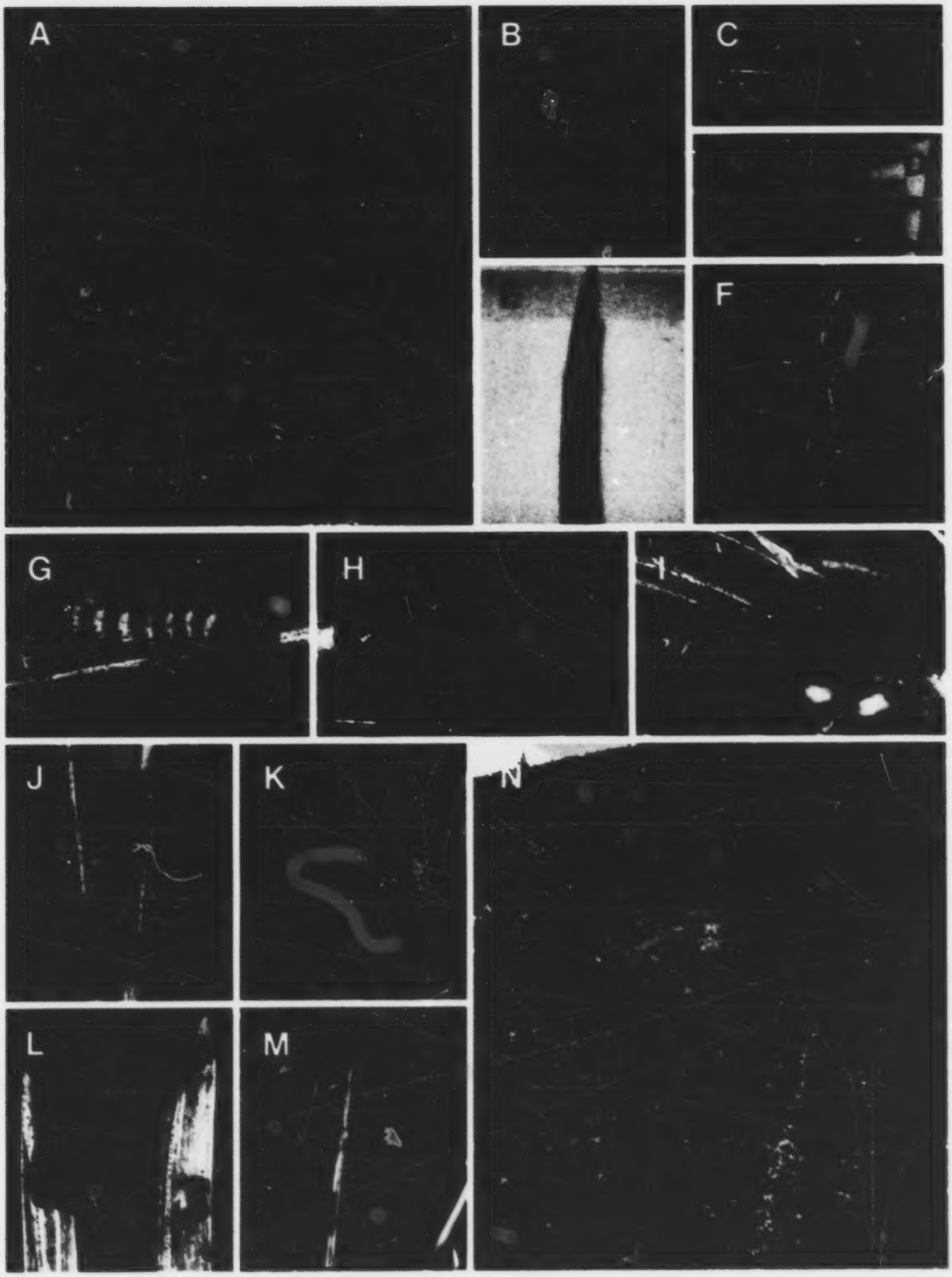
Little is known about the life history of ***T. gemmavitians***. Some galls (C) apparently continue to increase in size for several years, which suggests that the mites resemble the poplar bud gall mite, *Aceria parapopuli* Kieffer (Fig. 102), in their life history and habits.

Damage

None of these insects or mites are of economic importance in the prairie provinces. ***Paradiplosis tumifex – D. balsamicola*** infestations may cause premature needle drop. ***Mayetiola piceae*** infestions cause the affected shoots to curl and often to die. None are abundant enough to seriously affect the health of the trees, although they may disfigure ornamentals.

Bibliography: 79, 144, 213, 368, 437, 521, 522, 572

Figure 21. Galls on conifers. A. Galls on balsam fir needles caused by the balsam gall midge, *Paradiplosis tumifex* Gagné. **B.** Galls at the base of jack pine needles caused by *Eurytoma calycis* Bugbee. **C.** Galls on jack pine caused by the pine rosette mite, *Trisetacus gemmavitians* Styer et al. **D.** Cross-section of white spruce shoot showing the spruce gall midge, *Mayetiola piceae* (Felt), larva in its cell. **E.** External appearance of galls caused by *M. piceae*. **F.** Adult emergence holes from gall caused by *M. piceae*.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SPRUCE AND PINE NEEDLE MINERS (Figure 22)

Distribution, Hosts, and Importance

A number of insect species, including the spruce budworm (Fig. 6), mine the needles of spruce or pine as young larvae, but others spend all or most of the larval stage within the needles. Five of these that occur in the prairie provinces are the spruce needleminer, ***Endothenia albolineana*** (Kearfott); ***Coleotechnites*** sp. on jack pine; the orange spruce needleminer, ***Coleotechnites piceaella*** (Kearfott), mining the foliage of spruce and balsam fir; ***C. blastovora*** (McLeod), on spruce; and the northern lodgepole needleminer, ***C. starki*** (Freeman), on lodgepole pine. Although none of the species have been observed to cause tree mortality, *E. albolineana* is often abundant on a variety of spruces, particularly planted ones, and *C. starki* has reached outbreak proportions on lodgepole pine in the Cypress Hills and in Alberta's mountain parks.

Life Cycle and Appearance

Endothenia albolineana has one generation a year and overwinters in the larval stage. Pupation occurs in the spring, and adults emerge from late May until late June. They are small gray and brown moths (B) with a wingspan of 11–15 mm. The fore wings are marked with three irregular white bands. Eggs are laid in groups on the lower surface of the needles. The larvae hatch in mid-June or later and bore into the base of the old needles (C). There is usually one larva per mine. Small larvae may mine along one side of the needle, but older larvae remove all of the contents (D). The larvae are greenish in color with dark brown heads (E) and are about 8 mm long when fully grown. Groups of larvae web needles together with silk to form a nest (F). The larvae spin loose cocoons within the nest in which they overwinter. Some larvae complete their feeding during the first summer, but others do not do so until the following spring.

Young *Choristoneura fumiferana* larvae (Fig. 6) mine the foliage in early spring, before feeding on the developing buds. ***Coleotechnites piceaella*** larvae (H) mine the previous year's foliage or developing buds. Young larvae overwinter in silken hibernacula at the base of the needles and resume feeding in the spring. The larval head and thorax are brown, the body is orange-brown, and mature larvae are about 8 mm long.

Coleotechnites blastovora is believed to have a similar life cycle. The larvae (I) have reddish heads and thoracic shields and pinkish white bodies with red stripes. Larvae of the unidentified ***Coleotechnites*** species (G) have light brown heads, thoracic shields, and anal plates. The body is white, with transverse red bands on the rear of each segment.

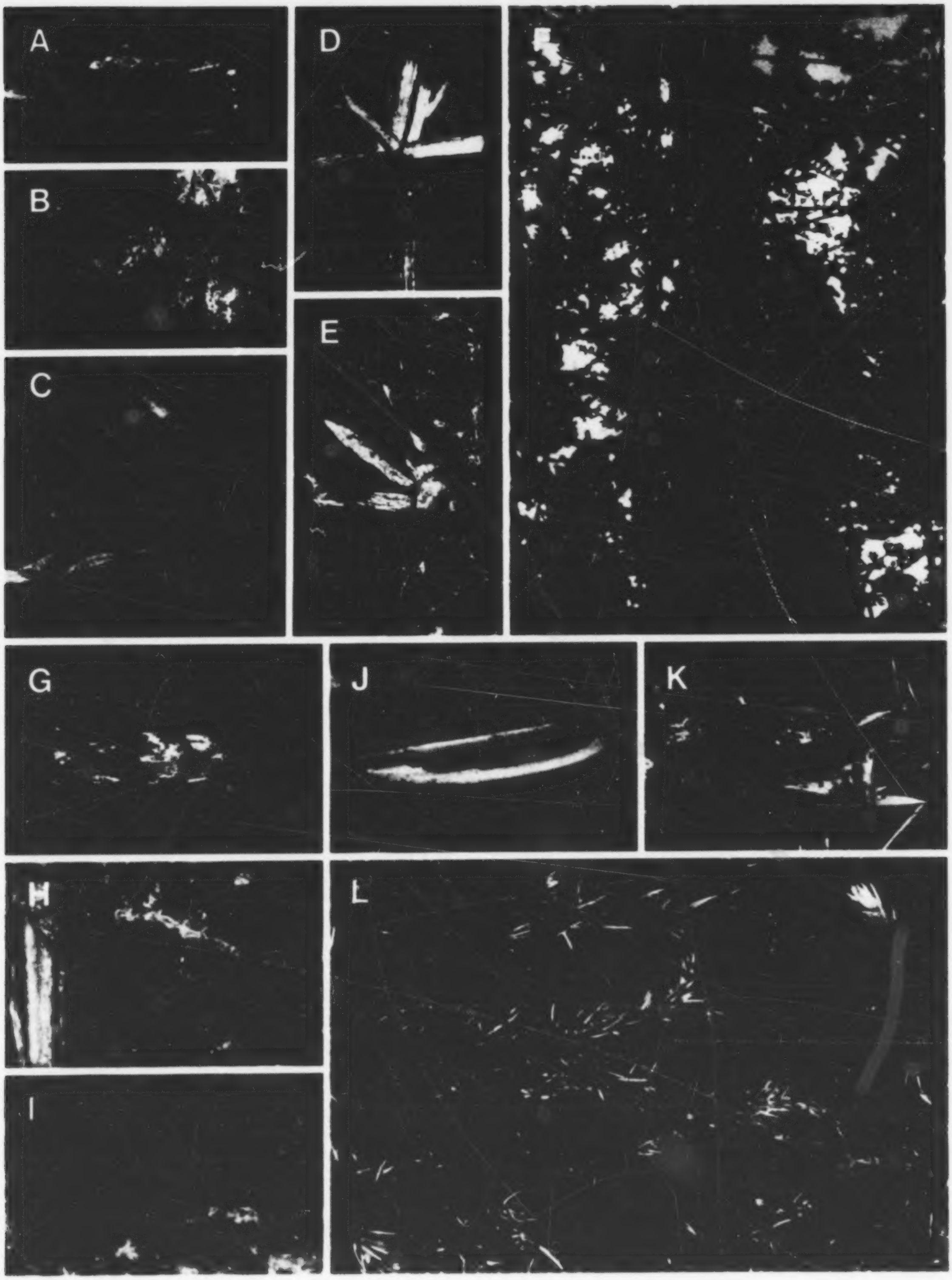
Coleotechnites starki has a 2-year life cycle and overwinters in the second and fourth larval instars. Pupation occurs in the mined needles during June of the second year, and the small gray moths (J) emerge from early July to early August. Populations are synchronized, so that adults are present only in even-numbered years. The moths have a wingspan of 12–14 mm, and the fore wings are variously marked in black. Eggs are usually deposited in old mines. The newly hatched larvae mine into the tips of new needles (K) in late August or early September and overwinter there. The larvae transfer to a fresh needle in June or July of the following summer, having completely destroyed the contents of the first needle. Mining of these needles is completed by the following May, when a third needle is attacked. These needles are also completely mined by the time larval development is completed in June (L). Early-instar larvae are lemon yellow to light orange in color, with light brown thoracic and anal shields and heads. The larvae get progressively darker with each molt, and mature larvae are brownish with dark brown or black shields and heads (L).

Damage

The nests (F) formed by ***E. albolineana*** sometimes persist for a year or more, and the feeding damage gives the trees an unhealthy appearance (A). Early-instar larval mines of ***C. starki*** affect the tips of the needles only, causing them to turn a reddish brown (K), and the needles mined by older larvae (J, L, M) also persist for a considerable period of time. The damage to affected stands is therefore quite noticeable (N), especially during the flight years. Annual incremental loss of heavily infested stands has ranged between 20 and 75%.

Bibliography: 110, 118, 139, 203, 274, 351, 477, 545, 546, 547, 569

Figure 22. **Spruce and pine needle miners. A.** White spruce tree showing the result of severe attack by the spruce needleminer, *Endothenia albolineana* (Kearfott), during the preceding summer. **B.** *E. albolineana* adult. **C.** Mined spruce needle, with larval entrance hole near base of needle. **D.** A group of mined spruce needles. **E.** Spruce needle opened to show larva in mine. **F.** Typical nest of mined needles formed by spruce needleminer larvae. **G.** *Coleotechnites* sp. larva on jack pine. **H.** Orange spruce needleminer, *C. piceaella* (Kearfott), larva. **I.** *C. blastovora* (McLeod) larva. **J.** Adult northern lodgepole needleminer, *C. starki* (Freeman). **K** Needle tips mined by young *C. starki* larvae. **L.** Mature *C. starki* larva in mined needle. **M.** Lodgepole pine needles mined by *C. starki*. **N.** Lodgepole pine stand showing damage caused by *C. starki* attack.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THE LARCH CASEBEARER AND PLAIN JUNIPER WEBWORM (Figure 23)

Distribution, Hosts, and Importance

The larch casebearer, ***Coleophora laricella*** (Hübner), was accidentally introduced into North America from Europe late in the 19th century. It feeds exclusively on various species of larch. Outbreaks have occurred on tamarack in eastern Canada at intervals of about 8 years. Spotty infestations have also occurred on western larch in British Columbia. The insect was first noted in southeastern Manitoba in 1965. Population expansion has been very slow since then, and no outbreaks have occurred.

The plain juniper webworm, ***Aethes rutilana*** (Hübner), is another introduced insect that feeds on common juniper in southern Alberta. It is of no economic importance in the forest but is a potentially serious pest of juniper in ornamental plantings.

Life Cycle and Appearance

Coleophora laricella has one generation per year. The adults emerge in June. They are small moths (A) with a wingspan of about 8 mm. The narrow front wings are silver or grayish brown in color, and the hind wings are fringed with hairs. The eggs are laid singly on the foliage, and the young larvae mine the foliage (C) until late summer. The larvae then line segments of one or more mined needles with silk to form cases (C), which they carry around with them as they feed, enlarging them as necessary. The larvae continue to mine the needles by reaching out from the cases. In the fall, the larvae fasten their cases to the twigs near a bud to overwinter (D, E). The larvae resume feeding in the spring (B). Mature larvae have black heads and reddish brown bodies and are about 6 mm long when fully grown.

Aethes rutilana has one generation per year and overwinters as young larvae in silk-lined tubes (H, K). The tube is attached to the twig and is covered with frass. The larvae (H, I) are yellowish, have brown heads, and reach a length of about 8 mm when mature. Mature larvae hollow out the concave sides of the needles (J) and spin extensive webbing (K). Pupation occurs in the feeding tubes, and the adults (G) emerge in June. They are small moths with a wingspan of 9–12 mm. The front wings are bright yellow, with four uniform deep red bands. The two outer bands are partially fused and often enclose a bright yellow spot. The hind wings are gray with a reddish tint.

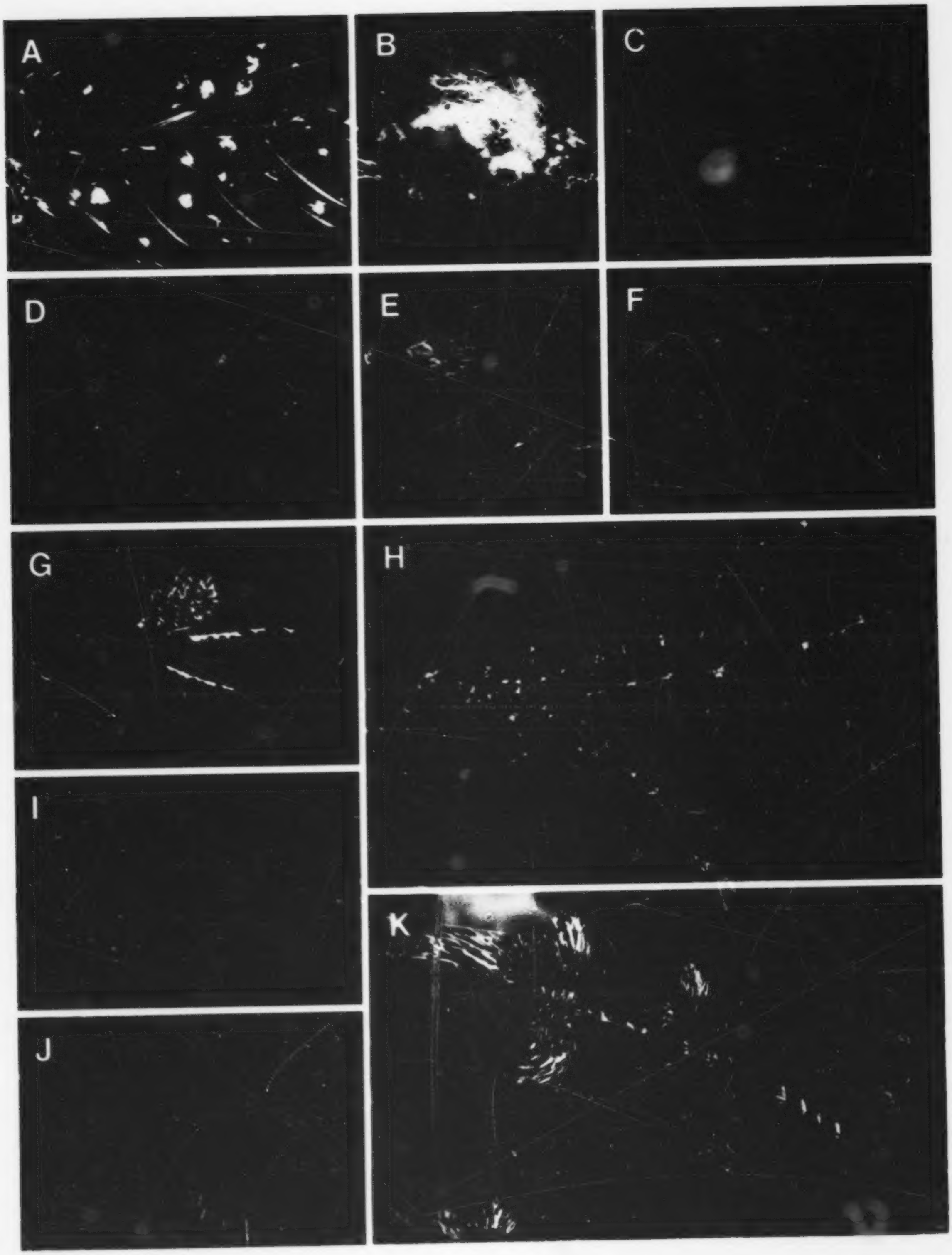
Damage

The mining habit of ***C. laricella*** causes the damaged foliage to dry out and become brownish in color (F). Most of the feeding damage is caused in early spring when the overwintering larvae resume feeding. Severely defoliated trees will refoliate, and the trees are thus able to survive repeated attacks with a minimum amount of tree mortality. The length and number of needles are reduced by repeated attacks, however, and radial increment is severely reduced. There may also be some branch and twig mortality. The amount of defoliation so far noted in Manitoba would have no discernible effect on tree growth.

Aethes rutilana is a wasteful feeder, and relatively few larvae can cause extensive damage (L). Repeated attacks are almost certain to weaken or kill the affected shrubs.

Bibliography: 139, 167, 186, 194, 203, 297, 368, 475

Figure 23. The larch casebearer, *Coleophora laricella* (Hübner), and the plain juniper webworm, *Aethes rutilana* (Hübner). A. Adult *C. laricella*. **B.** Late-instar *C. laricella* larva and case. **C.** Larch foliage mined by *C. laricella* larvae. Note larval case at arrow. **D.** Overwintering *C. laricella* cases attached to a larch twig. **E.** Overwintering *C. laricella* cases opened to show larva inside. **F.** Larch foliage damaged by larch casebearer feeding. **G.** *A. rutilana* adult. **H.** *A. rutilana* larva in silken tube. **I.** *A. rutilana* larva removed from tube. **J.** Juniper needled hollowed out by *A. rutilana* feeding. **K.** Close-up of *A. rutilana* feeding damage. **L.** *A. rutilana* feeding damage.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ADELGID GALLS ON SPRUCE (Figure 24)

Distribution, Hosts, and Importance

Several species of adelgids or woolly aphids belonging to the genera *Adelges* and *Pineus* cause galls to form on the new shoots of various spruces. They are not considered to be a pest in the forest, but they sometimes are in ornamental plantings. The dearth of taxonomic and life history studies has limited the amount of information available on the distribution and abundance of some species. All species have one or more of the spruces as a primary host, and all but one have another coniferous species as an alternate host.

The Cooley spruce gall adelgid, ***A. cooleyi*** (Gillette), attacks various spruces across Canada but is more abundant in the west, where its alternate host, Douglas-fir, is present. The spruce gall adelgid, ***A. laricatus*** (Patch), alternates between spruce and larch, ***A. strobilobius*** (Kaltenbach) attacks black and white spruce and alternates with larch, and the pine leaf adelgid, ***P. pinifoliae*** (Fitch), alternates between spruce and white pine. The range of all three species extends as far west as Alberta. The ragged sprucegall adelgid, ***P. similis*** (Gillette), has a transcontinental distribution. It attacks black and white spruce but has no alternate host.

Life Cycle and Appearance

Most of the above adelgids have complicated life cycles involving sexual and asexual reproduction and winged and wingless forms in addition to the host alternation already noted. Recognition of galls on the basis of their appearance is the only practical method of field identification. Only a specialist can identify the various forms of each species.

Host-alternating species require 2 years to complete their life cycle. ***Adelges cooleyi*** will be used as an example. The flocculent stage on Douglas-fir (Fig. 4) produces both winged and wingless parthenogenetic females in the spring. The wingless females remain on the Douglas-fir, but the winged forms migrate to spruce in the summer, where they lay eggs that develop into small wingless male and female aphids. After mating, each female lays a single egg at a node, between the twig and old bud scales. Female nymphs hatching from these eggs feed on the needles for a while, then migrate to the stem just below a bud, where they overwinter. Development is completed in the spring, and their feeding stimulates gall formation. Each adult female lays about 200 eggs. Nymphs hatching from these eggs migrate to the elongating new growth, where the galls are formed (C). The galls of *A. cooleyi* are typically elongate and pineapple shaped and may cause the shoot to curl if only one side is attacked. Gall formation does not cause a marked reduction in needle length on the gall. The winged parthenogenetic females emerging from the galls migrate to Douglas-fir to lay their eggs. The nymphs hatching from those eggs overwinter on the lower surface of the new foliage. There is also a wingless parthenogenetic form of *A. cooleyi* (A, B) that causes flocculence on spruce and is capable of reproducing itself without an alternate host. It is not clear if galls are produced under these conditions, but what appear to be *A. cooleyi* galls have been found in areas where no Douglas-fir is present.

Adelges laricatus and ***A. strobilobius*** have similar life cycles, alternating between their primary hosts and larch. Both produce short, pineapple-shaped galls that cause a marked reduction of needle length on the galls. Those caused by *A. strobilobius* are at the ends of the shoots (G, H, I), and those caused by *A. laricatus* have part of the shoot extending beyond the gall (J).

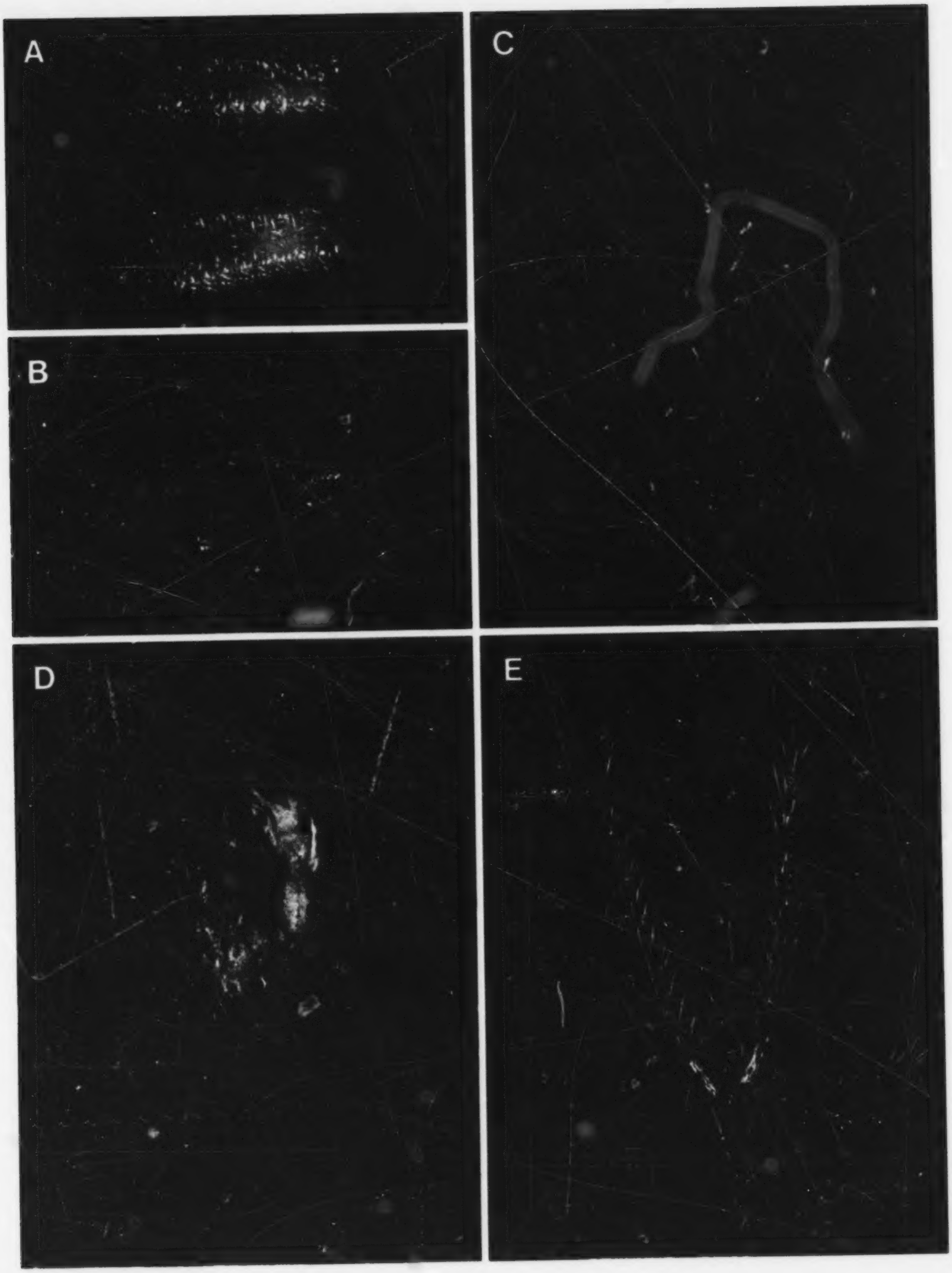
Pineus pinifoliae also has a complicated 2-year life cycle similar to that described for *A. cooleyi*, but the galls on spruce differ in appearance. The bases of the needles become flattened and scalelike (E) but are not fused together. ***Pineus similis*** has a relatively simple life cycle involving only parthenogenetic females. There are two generations per year. The most prolific generation, known as the stem mothers or fundatrices, overwinter as young nymphs usually at a node near the end of a twig. In the spring they resume feeding, which stimulates the formation of ragged looking galls on one or more shoots (F, K), and lay about 60 eggs. Most of the nymphs hatching from these eggs move to the new shoots and feed in the galls, but a few complete development on the needles. Winged and wingless females are produced. The wingless forms reinfest the same host tree, but the winged forms may migrate to other trees if environmental conditions are satisfactory.

Damage

The galls formed by these adelgids usually kill the affected shoots (D, F, G, I, K), although vigorous shoots may survive. The dead galls persist on the trees for several years. The health of the tree is usually not adversely affected unless the infestation is over a prolonged period. Heavily infested trees may become very unsightly.

Bibliography: 9, 16, 119, 120, 121, 122, 336, 368

Figure 24. Adelgid galls on spruce. A. Flocculence on white spruce foliage produced by the Cooley spruce gall adelgid, *Adelges cooleyi* (Gillette). **B.** Flocculence lifted to show *A. cooleyi* nymphs. **C.** Young gall on white spruce caused by *A. cooleyi*. **D.** Mature *A. cooleyi* gall on white spruce. **E.** Young and mature gall on white spruce caused by the pine leaf adelgid, ***Pineus pinifoliae*** (Fitch). **F.** Old gall on white spruce caused by the ragged sprucegall adelgid, *P. similis* (Gillette). **G.** Mature gall on white spruce caused by ***Adelges strobilobius*** (Kaltenbach). **H.** White flocculence and young gall on white spruce caused by *A. strobilobius*. **I.** Old galls on black spruce caused by *A. strobilobius*. **J.** Young gall on white spruce caused by the spruce gall adelgid, *A. laricatus* (Patch). **K.** White spruce branch heavily infested with *P. similis*.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SHOOT- AND BUD-BORING INSECTS (Figure 25)

Distribution, Hosts, and Importance

Insects that bore into the shoots of balsam fir and buds of black and white spruce are minor pests in the prairie provinces. Light-to-moderate infestations of the balsam shootboring sawfly, ***Pleroneura brunneicornis*** Rohwer, have been reported from all three provinces, but all appear to have been short-lived. Information on the distribution and abundance of the spruce bud midge, ***Rhabdophaga swainei*** Felt, in the prairie provinces is scanty, but the insect is probably common. Surveys in Ontario showed that the insect is more abundant than is generally realized, because the symptoms indicating attack are so inconspicuous that infestations are not usually noticed.

Life Cycle and Appearance

Pleroneura brunneicornis has one generation per year and overwinters as a larva or pupa in a thin cocoon spun in an earthen cell. Adult sawflies emerge in the spring and are 4.5-5.5 mm long. They begin laying eggs when the bud scales on balsam fir start to drop. A single egg is deposited near the tip of the shoot, and the feeding of the young larva causes a slight browning of the host tissues. The larvae are small creamy-white grubs with rudimentary thoracic legs and are 4-7 mm long at maturity (A). They burrow into the axes of the shoots and mine towards the base (B). The larvae crawl out of the shoot when feeding is completed in midsummer and drop to the litter to spin cocoons.

Rhabdophaga swainei has one generation per year; it overwinters as a late-instar larva in a cell formed in the terminal bud (D). Fully grown larvae are pinkish in color and are about 2 mm long. Pupation occurs in a hardened cell within the gall, and the adults emerge in the spring. They are typical long-legged reddish brown midges, about 2.5 mm long. The females lay their eggs between the basal scales or between the needles on the expanding shoot. They usually lay only one egg per shoot, but two or more eggs are sometimes laid. Upon hatching, the young larvae move to the tip of the elongating shoot, which they enter by burrowing into the soft base of a needle. They apparently remain dormant until late summer or early fall when they begin feeding, completing most of their development before freeze-up.

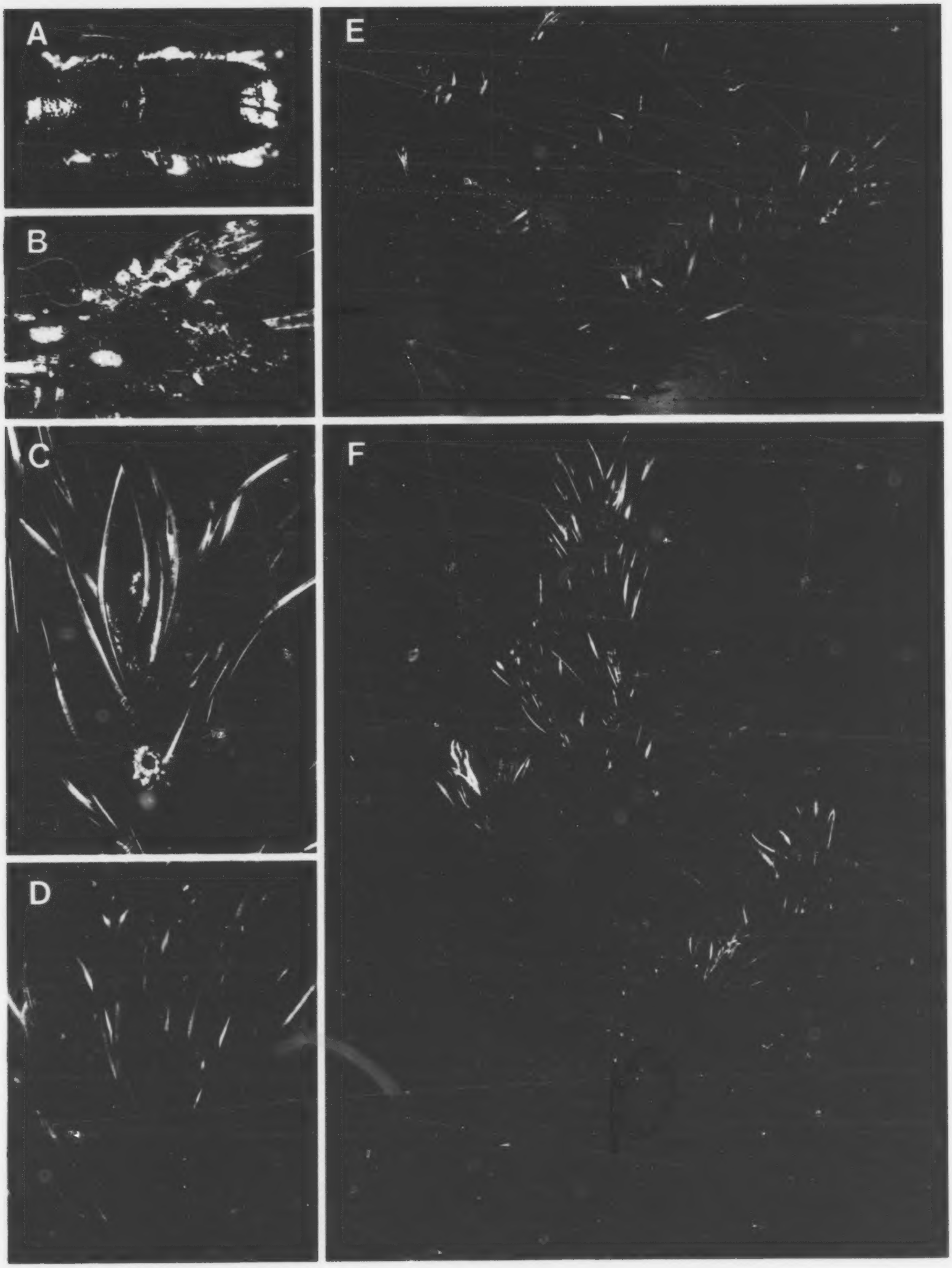
Damage

Pleroneura brunneicornis prefers young balsam fir trees about 2 m in height, particularly those growing in the open. Most of the damage occurs on branch whorls 2-4 years old, and the leader is rarely attacked. The tunneling of the larvae causes shoot deformity (C), and these shoots usually die. The foliage then turns a reddish brown that resembles frost damage, and the dead parts of the shoots eventually fall off. Affected trees are unsightly until this natural pruning occurs, but the tree is not severely damaged.

Rhabdophaga swainei prefers the sunny side on open growing spruce trees 2-4 m in height. Growth of the affected buds is arrested, and this creates bushy growth. Multiple leaders may develop if the leader is attacked (E), and this may lead to forked trunks. Some height loss occurs, but this is usually minimal.

Bibliography: 92, 104, 178, 338, 526, 531, 586, 601

Figure 25. Shoot- and bud-boring insects. A. Lateral and dorsal views of larvae of the balsam shootboring sawfly, *Pleroneura brunneicornis* Rohwer. **B.** *P. brunneicornis* larva in balsam fir shoot. **C.** Balsam fir shoots damaged by *P. brunneicornis*. **D.** Larva of the spruce bud midge, *Rhabdophaga swainei* Felt, in a white spruce bud. **E.** Multiple leaders on white spruce caused by *R. swainei* attack.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SHOOT-BORING BARK BEETLES ON PINE (Figure 26)

Distribution, Hosts, and Importance

A shoot-boring bark beetle, ***Pityophthorus boycei*** Swaine, was collected from jack pine in southeastern Manitoba. This species had been previously reported in Canada only from southern British Columbia, where its hosts were lodgepole pine and ponderosa pine. Nothing is known about the extent of its distribution in the prairie provinces. It is probably of no economic importance, but it was one of the most common shoot borers in the plantation where it was discovered.

A related species, ***P. fivazi*** (Blackman), attacks red pine in Michigan. It has not been reported from Canada but may occur on red pine in southeastern Manitoba.

Life Cycle and Appearance

The life cycle of *P. boycei* appears to be similar to that of *P. fivazi*. ***Pityophthorus boycei*** adults (A) are small, stout, brown or black bark beetles about 3 mm long. The elytral declivity is oblique, and the front of the pronotum is broadly rounded. The adults bore into the shoot a few centimetres from the tip, forming a pitch tube (C). They tunnel into the pith and construct a nuptial chamber, then excavate a short egg gallery in the pith and deposit a few eggs in niches along the side of the gallery. The adults then apparently leave the shoot and attack other shoots. This may explain why several damaged shoots are often found in close proximity to one another (F). The larvae feed on the pith, wood, and inner bark, then pupate in the gallery (B). One to three pupae were typically found in each infested shoot. In the laboratory, some adults emerged from the shoots in the fall, but the majority did not. It is not known if the adults overwinter in the twigs or duff. There is probably one generation per year in the prairie provinces.

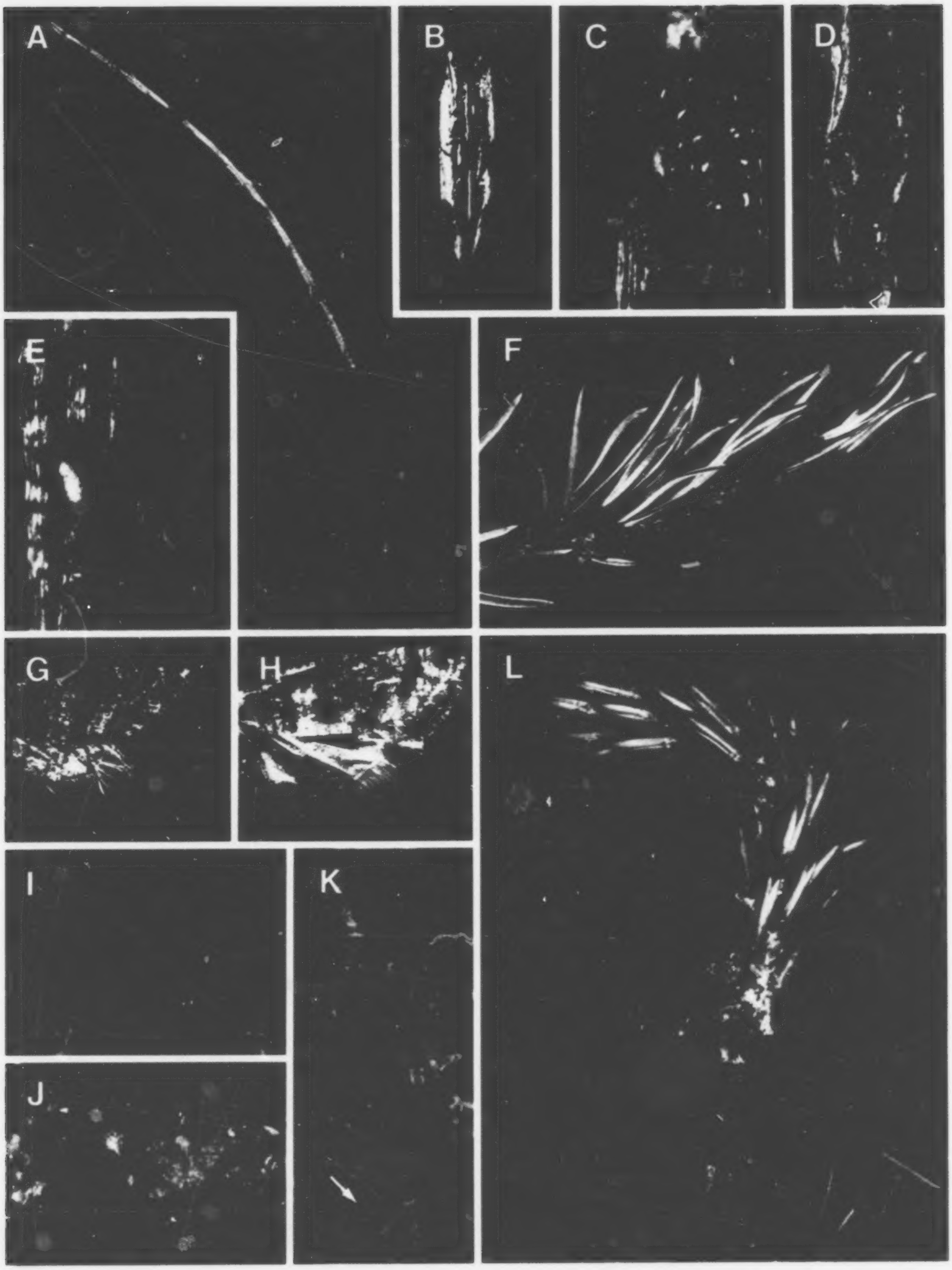
P. fivazi adults are very similar to those of *P. boycei* but are slightly smaller, and the anterior of the pronotum is narrowly rounded.

Damage

Larval feeding kills the tips of the affected shoots (C, D, E, F), and subsequent growth becomes bushy (E). No damaged leaders were observed in the area where the collections were made, so damage is probably minimal. It should be noted, however, that upper branchlets seem to be preferred, so that leader damage remains a possibility.

Bibliography: 46, 61

Figure 26. Shoot-boring bark beetles on pine. A. Adult *Pityophthorus boycei* Swaine. **B.** *P. boycei* pupae in mined jack pine shoot. **C.** Pitch tube on jack pine shoot killed by *P. boycei* attack. **D.** Jack pine shooted killed by *P. boycei*. **E.** Bushy growth caused by *P. boycei* attack the previous year. **F.** Several shoots killed by *P. boycei*.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SHOOT BORERS OF LARCH AND PINE (Figure 27)

Distribution, Hosts, and Importance

The larch shoot moth, ***Argyresthia laricella*** Kearfott, attacks tamarack and western larch (but not alpine larch) and probably occurs throughout the range of tamarack. Some specimens collected in the prairie provinces, however, are not typical and will be referred to as *A*. nr. *laricella* because further study is required to clarify their taxonomic status.

The jack pine shootborer, ***Rhyacionia granti*** Miller, and the yellow jack pine shootborer, ***R. sonia*** Miller, attack the shoots of jack pine in southeastern Mantioba. ***Rhyacionia adana*** Heinrich attacks Scots, red, and jack pines. It has been reported from northwestern Ontario and may occur in southeastern Manitoba. The most serious pest in the genus is the European pine shoot moth, ***R. buoliana*** (Dennis & Schiffermüller), which attacks red, Scots, and other pines. The insect is present in Ontario and British Columbia but has not yet been reported from the prairie provinces.

Life Cycle and Appearance

The described life cycle for ***A. laricella*** is apparently similar to *A*. nr. *laricella* in the prairie provinces. There is one generation per year, and fifth-instar larvae overwinter in the infested shoots (A), which are most noticeable soon after the foliage flushes. The larvae (C) have yellow bodies and dark brown heads and thoracic shields. Mature larvae are about 7 mm long. They cut a circular hole through the bark, which they cover with silk (E) before pupating in the tunnel (D). The adults emerge through this hole about 1 month later. Some of the moths (B) in the prairie provinces are slate gray, and others are pale. They have a wingspan of about 8 mm and emerge in late June or early July. Eggs are laid on the new shoots. The larvae tunnel in the cambial area of the twig during the late summer and fall. Feeding is completed in the spring.

Rhyacionia granti has one generation per year and overwinters as pupae in the duff. The adults emerge in the spring and have a wingspan of 15–20 mm. There are alternating light gray and brown bands on most of the fore wing (G), and the hind wings are gray with a conspicuous rear fringe. Eggs are laid on the developing shoots, into which the larvae tunnel, leaving only the bark (K). Mature larvae (I, L) have reddish brown bodies, dark reddish brown heads, and are about 15 mm long. They cut an emergence hole (J) and drop to the ground to pupate. The shoots remain green while the larvae are feeding but die and turn brown before the needles complete their growth. ***Rhyacionia sonia*** adults have a wingspan of about 12 mm. The front wings (H) have alternating light gray and reddish brown bands. The hind wings are gray and tinged with brown and have a gray fringe. The moths emerge from the duff in June or early July and lay their eggs on the new shoots. The yellowish brown larvae bore in the shoots and reach a length of about 9 mm when fully grown. The needles are nearly mature before they die (F), and by this time the larvae have dropped to the ground to pupate.

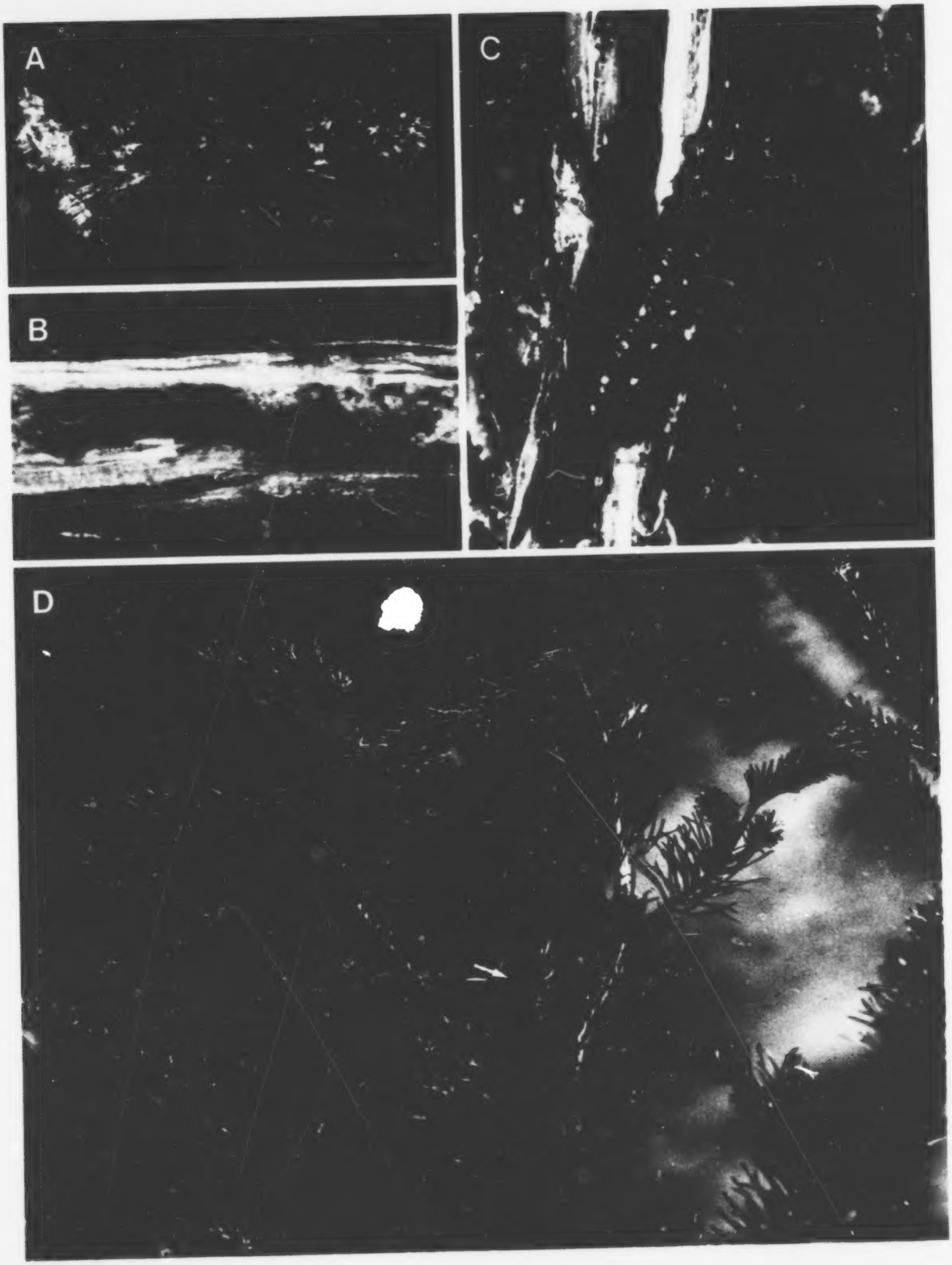
Rhyacionia adana adults resemble those of *R. granti*. They emerge early in the spring and lay their eggs near the base of the needles on trees less than 1 m in height. The larvae mine the base of the old needles and then move to the developing new shoots, where they feed within the needle sheath or burrow into the shoot. The larvae are yellowish brown to reddish brown and reach a length of 7–10 mm. The shoots do not turn brown until the larvae have dropped to the ground to spin cocoons at the root collar. ***Rhyacionia buoliana*** adults emerge in June or July and have a wingspan of 18–22 mm. The front wing is orange with silver bars. Eggs are laid on the new shoots, and the young larvae mine the base of the needles, causing them to turn brown and die. In late summer or fall, the larvae burrow into the buds, where many overwinter. In the spring, the larvae bore into a developing bud or shoot to complete their feeding. The larvae are brown with dark brown heads and are about 15 mm long at maturity.

Damage

Argyresthia nr. ***laricella*** usually kills all or part of the terminal growth on the affected twigs. Large-diameter shoots may not be killed, but 2 years' growth is often killed if the twigs are slender. ***Rhyacionia granti*** (L) and ***R. adana*** usually kill the affected twigs before the needles are fully developed; shoots attacked by ***R. sonia*** (F) do not die until later. None of these three species have caused significant damage in this region. ***Rhyacionia buoliana*** often kills the terminal bud, and repeated attacks cause cabbage-topped trees.

Bibliography: 139, 162, 165, 335, 351, 365, 368, 409, 411, 453, 475

Figure 27. Shoot borers of larch and pine. A. Tamarack shoot killed by a larch shootborer, *Argyresthia* nr. *laricella* Kearfott. **B.** Adult *A.* nr. *laricella*. **C.** *A.* nr. *laricella* larva. **D.** *A.* nr. *laricella* pupa in tunneled shoot. **E.** Silk-covered emergence hole made by *A.* nr. *laricella* larva. **F.** Jack pine shoot killed by the yellow jack pine shootborer, *Rhyacionia sonia* Miller. **G.** Right wing of jack pine shootborer, *R. granti* Miller, adult. **H.** Right wing of *R. sonia* adult. **I.** *R. granti* larva. **J.** Emergence hole in jack pine shoot made by *R. granti* larva. **K.** Jack pine shoot tunneled by *R. granti* larva. Note emergence hole at arrow. **L.** Jack pine shoot killed by *R. granti* larva.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THE EASTERN PINE SHOOTBORER (Figure 28)

Distribution, Hosts, and Importance

The eastern pine shootborer, ***Eucosma gloriola*** Heinrich, attacks jack pine, white pine, Scots pine, and red pine. It is native to North America, and its distribution closely approximates the natural range of white pine, its preferred host, although infestations in Manitoba have been observed only on jack pine. It is found primarily in young, open-growing stands and is occasionally a serious pest in Christmas tree plantations.

Life Cycle and Appearance

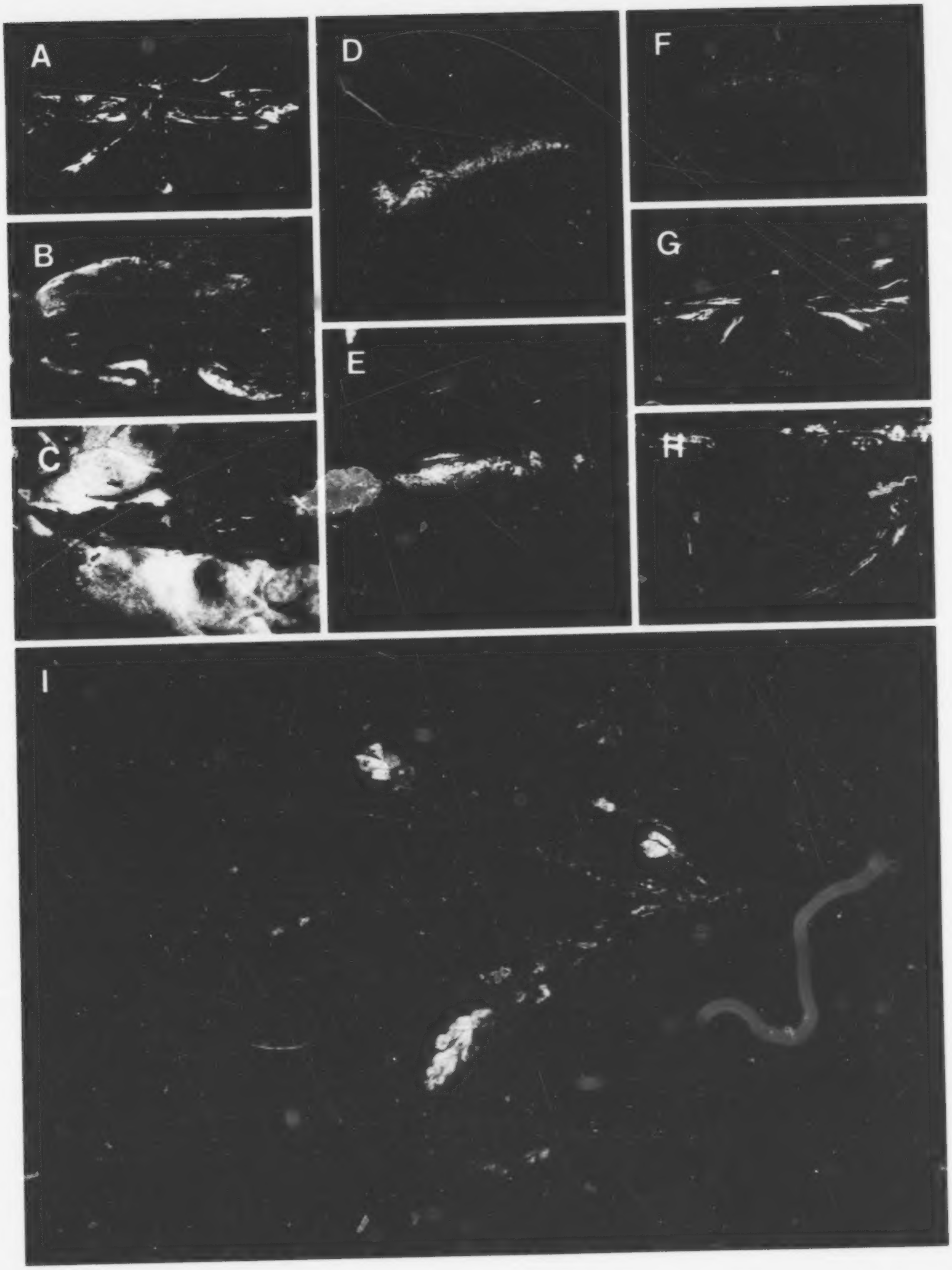
Eucosma gloriola has one generation per year and overwinters as pupae in the soil. The adults (A) emerge in late May or early June and have a wingspan of 13–16 mm. The front wings are reddish copper, and each have two transverse gray bands; the hind wings are gray with a brownish suffusion at the edges. The eggs are laid on the needle sheaths or elsewhere on the developing shoots, and the larvae enter the shoots by boring under the needle sheaths, lateral buds, or young cones. The young larvae bore into the pith and tunnel toward the base of the shoot during most of the larval period. There is usually only one larva per terminal shoot, but as many as six per shoot have been observed in heavy infestations. Frass is not expelled but is packed tightly behind the larvae. The larvae (B, C) have dark brown heads, brownish thoracic shields, and pale brown bodies. There are five larval instars, and mature larvae are about 13 mm long. Tunnels are 10–29 cm long. Fifth-instar larvae reverse direction and tunnel upward for several centimetres before chewing a series of notches in the new wood, girdling the shoot. After boring for an additional 5–10 cm, the larvae chew exit holes through the bark. The larvae leave the shoots through these holes and enter the litter, where they spin thin silken cocoons that incorporate particles of soil debris. The resulting cocoon is inconspicuous and resembles a lump of soil litter. Pupation occurs soon after the cocoons are formed.

Damage

The girdling of the shoots weakens them so that they wilt or break at the point of girdling during high winds (D). Shoots that do not break may eventually recover, but growth is usually distorted. The insect seems to prefer the leaders, and repeated attacks may cause cabbage-topped trees. Severe damage to Christmas trees may make the trees unmarketable during the year of attack.

Bibliography: 125, 138, 139, 474, 642, 643, 648

Figure 28. The eastern pine shootborer, *Eucosma gloriola* Heinrich. A. Adult *E. gloriola.* **B.** *E. gloriola* larva in shoot. **C.** Close-up of *E. gloriola* larva. **D.** Jack pine regeneration infested with *E. gloriola.* Both of the current leaders are infected, and the stub of original leader (at arrow) is evidence of an earlier attack by *E. gloriola.*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THE BROWN CEDAR LEAFMINER AND ITS ALLIES (Figure 29)

Distribution, Hosts, and Importance

The brown cedar leafminer, ***Coleotechnites thujaella*** (Kearfott), attacks eastern white cedar and has been reported as far west as central Saskatchewan. The cedar leafminer, ***Argyresthia aureoargentella*** Brower, the arborvitae leafminer, ***A. thuiella*** (Packard), and ***A. freyella*** Walsingham have all been collected on eastern white cedar in southeastern Manitoba. The orange larch tubemaker, ***Coleotechnites laricis*** (Freeman), attacks larch and probably occurs throughout the region.

None of these insects are of economic importance in the region, but serious infestations of the cedar leaf miners have occurred in eastern Canada.

Life Cycle and Appearance

Coleotechnites thujaella has one generation per year and overwinters as second- or third-instar larvae in the mined foliage. Feeding is completed in the spring, and the adults (A), which have a wingspan of about 9 mm, emerge in late June or July. The moths have narrow white front wings that have three blackish transverse bands and long fringes on the rear edge. The larvae (B) are reddish brown, with dark brown heads, thoracic shields and anal plates and are about 6–7 mm long at maturity. They eat the contents of all three leaflets (I), and pupation occurs within the mines (C).

All three *Argyresthia* species of cedar leaf miners have similar life cycles. Each has one generation per year, and all overwinter as late-instar larvae in the mined foliage. Feeding is completed in the spring, and the brown and white moths, which have a wingspan of 7–9 mm, emerge in June or early July. ***A. aureoargentella*** larvae are light to dark green in color and are 6–7 mm long when mature. They usually mine one-and-one-half leaflets and spin a spindle-shaped white cocoon (D) on the foliage before pupating. ***A. freyella*** larvae are similar and have similar habits, but the cocoon (E) is slightly smaller, is flecked with brown, and is usually spun on the underside of the foliage. ***A. thuiella*** larvae (F) are gray, grayish green, or brown, with dark brown heads. They usually mine all three leaflets and pupate within the mined needles.

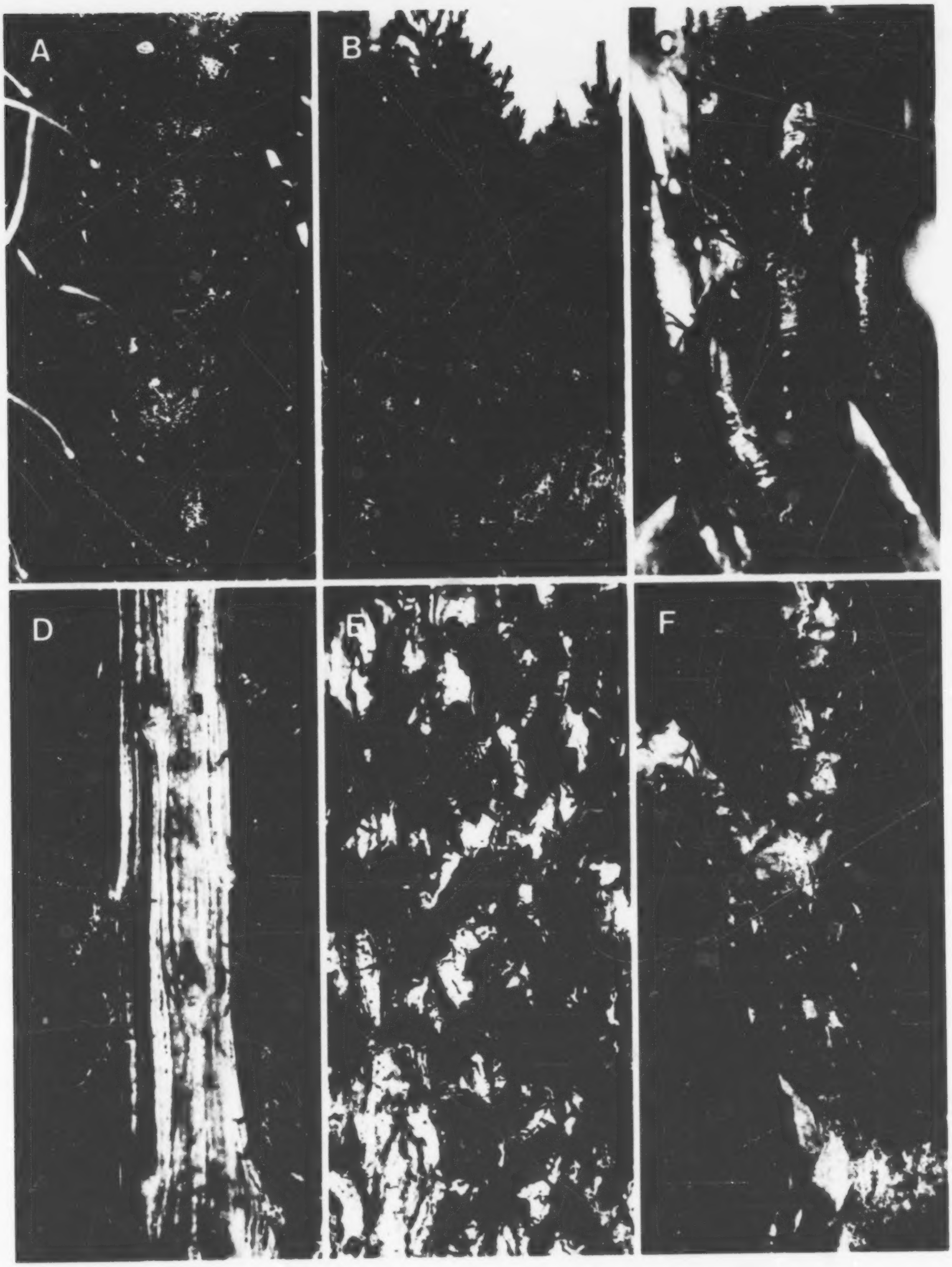
Coleotechnites laricis adults (G) have narrow blackish front wings with a span of about 10 mm. Both the front and hind wings have fringes along the rear edge. The adults emerge in midsummer, and there is one generation per year. Young larvae mine the bases of two or three needles before using these needles to form a shelter on the twig in which they overwinter. In the spring, the larvae tie bundles of needles together to form a tube (H) and eat the apical portions of the needles. They are orange in color without conspicuous markings and are about 8 mm long when fully grown. Pupation occurs in the original tube or in another formed nearby.

Damage

The cedar leaf miners remove the leaf contents (I), causing death of the affected parts. Infestations in Manitoba have been light so far, and little damage has occurred, but severe infestations may kill branches or entire trees. Damage by ***C. laricis*** is seldom severe enough to affect the vigor of the host tree.

Bibliography: 139, 194, 198, 351, 368, 425, 458, 475, 513, 514

Figure 29. The brown cedar leafminer, *Coleotechnites thujaella* (Kearfott), and its allies. A. Adult *C. thujaella*. **B.** *C. thujaella* larva. **C.** *C. thujaella* pupa. **D.** Cedar leafminer, *Argyresthia aureoargentella* Brower, cocoon. **E.** *A. freyella* Walsingham cocoon. **F.** Arborvitae leafminer, *A. thuiella* (Packard), larva. **G.** Adult orange larch tubemaker, *C. laricis* (Freeman). **H.** Tube formed on tamarack by *C. laricis* larva. **I.** Twig of eastern white cedar damaged by *C. thujaella* (three leaflets) and by *A. aureoargentella* (one-and-one-half leaflets). Some of the three-leaflet damage away from the tips may be caused by *A. thuiella*.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APHIDS ON CONIFERS (Figure 30)

Distribution, Hosts, and Importance

Most of the aphids attacking conifers belong to the genus *Cinara*. Specialists disagree on which species should be included in the genus, but some estimate that it includes more than 175 species worldwide. More than 50 species occur in Canada, and probably about 30 of these can be found in the prairie provinces. Almost every species of conifer is attacked by a species of *Cinara*; some may be attacked by one species only and others by as many as nine. Each species of aphid apparently has a specific host, but because more than one species may attack a given host it is almost impossible for anyone but a specialist to identify the aphids in the field. Ants often tend the aphid colonies.

Life Cycle and Appearance

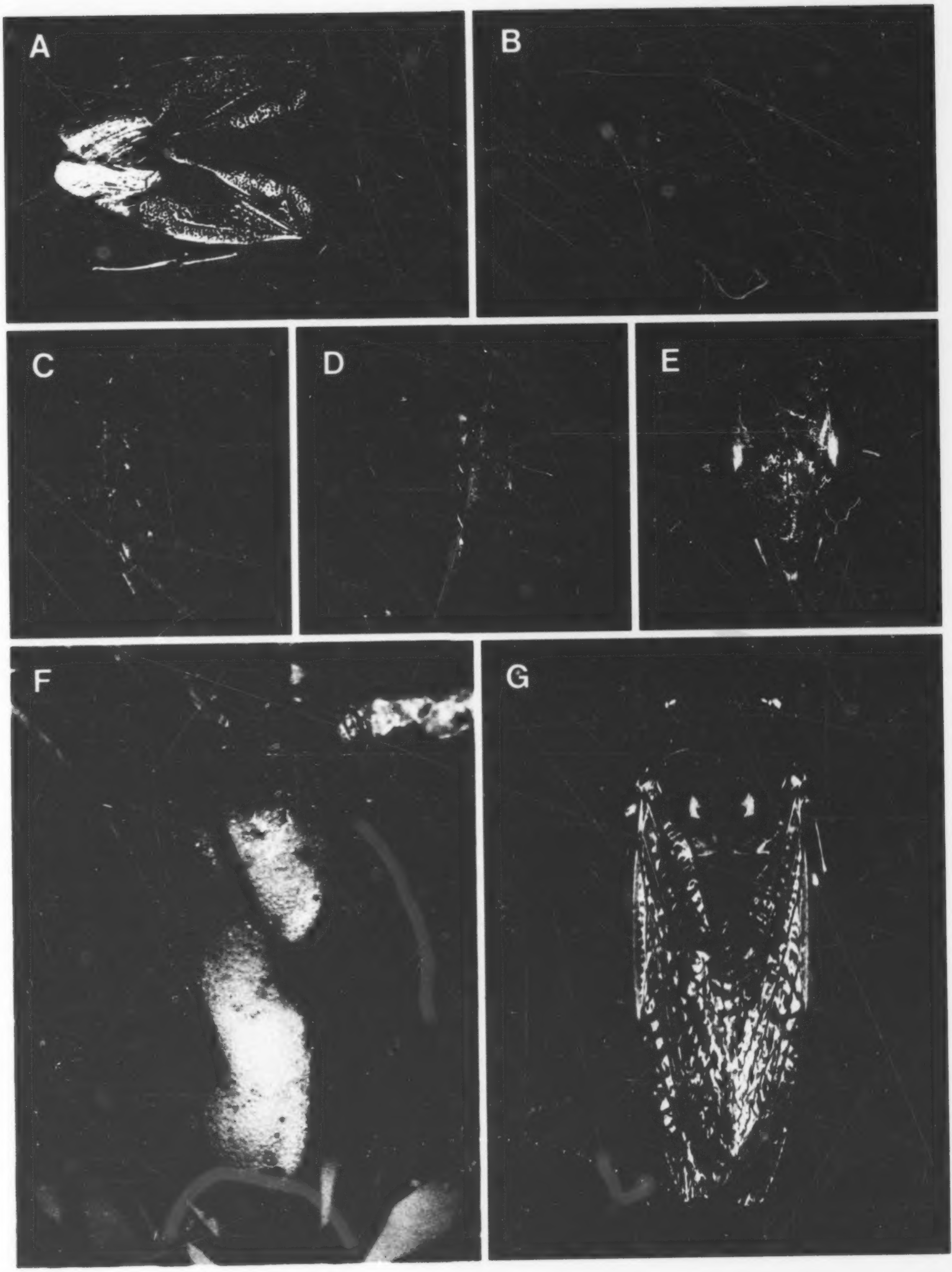
The various species of *Cinara* all have similar life cycles in the prairie provinces, and there may be as many as six generations annually, depending upon weather and location. All overwinter as eggs that are attached to the foliage or, in the case of the larch-infesting species, the twigs. The eggs hatch in early spring, and the nymphs feed on the twigs or small branches. The nymphs develop into asexual females (known as fundatrices) that produce nymphs without mating. These nymphs develop into winged and wingless females that also produce nymphs without mating. The winged females disperse to new hosts before starting to reproduce, and the wingless ones gradually move to the trunk and larger branches as the season progresses. This process is repeated several times during the summer. A sexual generation is produced in late summer or early fall. The females of this generation have wings, and the males may be winged or wingless, depending upon the species. After mating, the females move to the foliage or twigs to deposit their eggs. Examples of *Cinara* species on alpine fir (A), lodgepole pine (C), tamarack (D), white spruce (E), and of *C. cupressi* (Buckton) on white cedar (F) are presented to show the general appearance of aphid colonies on conifers.

Damage

Damage caused by aphid feeding is usually minimal unless the infestations are very severe and persist for several years. Severe infestations may cause foliage discoloration (B), leading to premature needle drop, and the copious amounts of honeydew produced by large colonies is sometimes infested with sooty mold. This gives the trees an unsightly appearance, which may be objectionable in ornamental plantings, but aphid feeding has little long-term adverse effects on the trees.

Bibliography: 55, 56, 57, 139, 203, 474, 475, 477

Figure 30. Aphids on conifers. A. Adult of *Cinara* sp. on alpine fir. **B.** Yellowing of lodgepole pine needles caused by *Cinara* sp. **C.** Colony of *Cinara* sp. on lodgepole pine. **D.** Colony of *Cinara* sp. on tamarack. **E.** Colony of *Cinara* sp. on white spruce. **F.** Colony of *C. cupressi* (Buckton) on white cedar.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SPITTLEBUGS AND THEIR ALLIES (Figure 31)

Distribution, Hosts, and Importance

Stink bugs, spittlebugs, and cicadas are relatively large sucking insects that are found on conifers. Some species of spittlebugs occasionally become locally abundant, but none of these insects are of economic importance in the prairie provinces.

The banasa stink bug, ***Banasa dimidiata*** (Say), and ***Chlorochroa persimilis*** Horvath occur throughout the region and in Manitoba, respectively. They feed primarily on hardwoods or herbaceous vegetation but are found occasionally on pine, cedar, and juniper.

The pine spittlebug, ***Aphrophora cribrata*** (Walker), feeds primarily on Scots pine, but it also feeds on jack pine and other softwoods. It occurs as far west as Saskatchewan, although it is most abundant in southeastern Manitoba. The Saratoga spittlebug, ***A. saratogensis*** (Fitch), attacks red pine and jack pine and occasionally white pine in southeastern Manitoba. The boreal spittlebug, ***A. gelida*** (Walker), occurs throughout the region on pine, spruce, tamarack, and Douglas-fir.

The cicada, ***Okanagana rimosa*** (Say), is common in jack pine and lodgepole pine stands throughout the region.

Life Cycle and Appearance

Little is known about the life cycles of the two stink bugs mentioned above. They apparently overwinter as adults and have five nymphal instars. Mature nymphs resemble the adults, but the wings are not fully developed. ***Banasa dimidiata*** apparently has one generation per year, and the adults (A) are 7-10 mm long. They are typically bright green with darker markings, but the coloration is variable. Much of the green on the pronotum, scutellum (exposed top of second thoracic segment), and wings is often replaced by reddish brown or purple. ***Chlorochroa persimilis*** may have two generations per year and is usually most common in areas with dry, sandy soil. The adults (B) are 11-15 mm in length and are green with reddish brown markings on the edges of the pronotum that also extend onto the base of the wings.

The life histories of the *Aphrophora* species are not fully understood. All three species mentioned have one generation per year and probably overwinter in the egg stage in slits cut into twigs on the adult host. The nymphs have five instars and feed under spittle (a frothy mass), which serves to protect them from desiccation. The adults are characterized by a long beak, a broad head, and smooth fore wings with prominent punctures. ***Aphrophora cribrata*** adults (C) are 9-11 mm long. They have a long crown (top of the head) with a pale middorsal line, a large globular sucking pump, and black-barred brownish fore wings that are flared so that the body is widest at the middle of the wings. The nymphs feed under spittle masses (F) on the same hosts as the adults. ***Aphrophora saratogensis*** adults (D) are slender and are 8-10 mm long. The crown is short with a broad middorsal yellow stripe, the scutellum is pale, and the front wings are orange or orange-brown with grayish white markings. The nymphs feed on sweet fern or other forbs. ***Aphrophora gelida*** adults (E) also have a large sucking pump and are 9-11 mm long. They are robust, resembling those of *A. cribrata* in form, but have a pale patch on the front wings. The coloration is variable, but the front wings are usually variegated and have a dark stripe extending diagonally from the scutellum to the outer edge of the wing. The nymphs feed on goldenrod, fireweed, and other forbs.

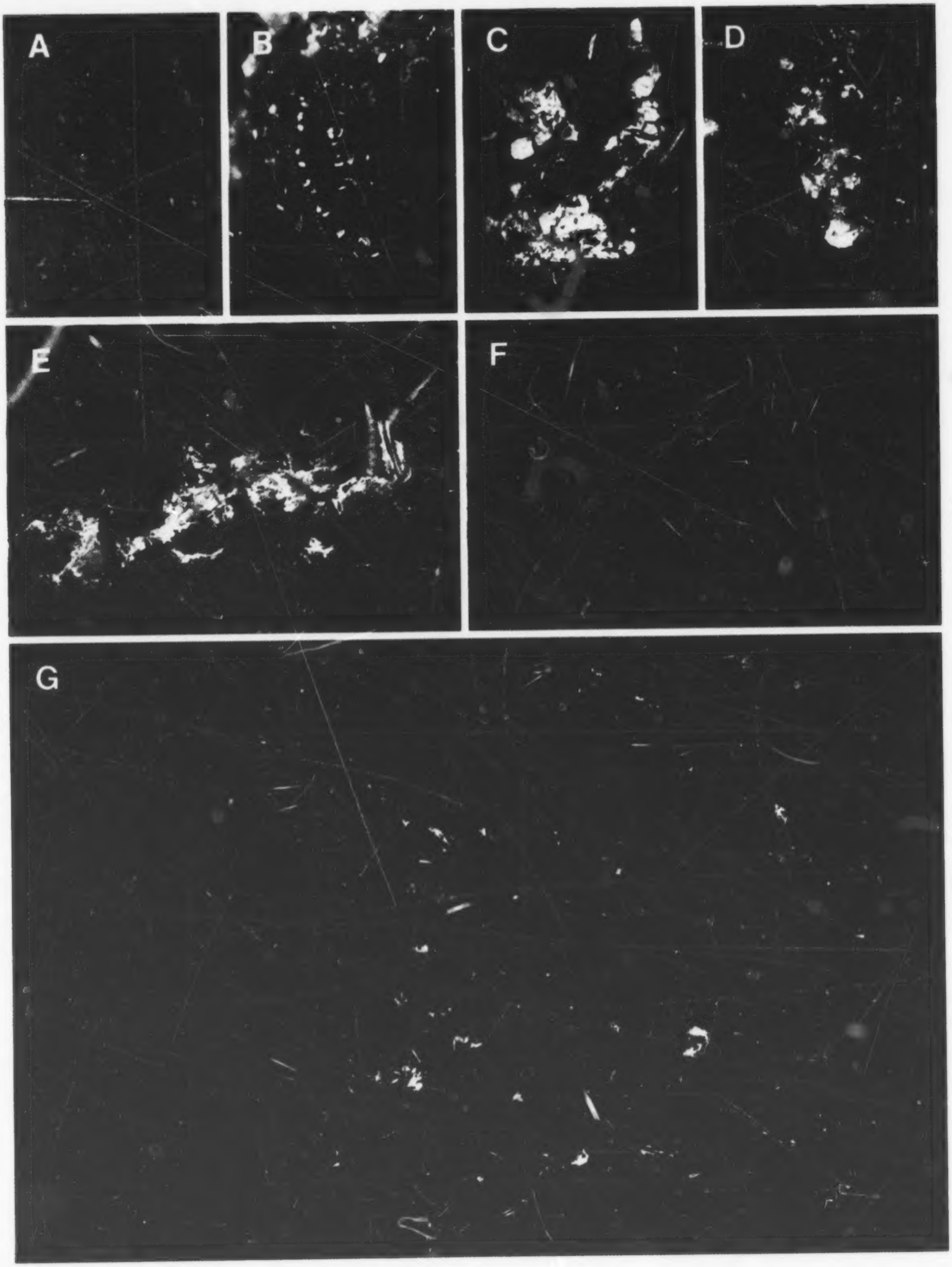
Okanagana rimosa apparently has a 4-year life cycle. The adults (G) emerge during the early summer, are about 30 mm long, and have a wingspan of about 60 mm. They are variable in color but are typically black with red markings that fade to yellowish in pinned specimens. The females cut egg pockets into the twigs of trembling aspen or other hardwood shrubs and lay several eggs in each. The nymphs hatch in about 10 days and enter the soil, where they feed on the roots of pine. Mature nymphs crawl up the base of the pines or deciduous shrubs before molting to the adult stage.

Damage

Stink bug feeding damage is probably of little concern. Spittlebug feeding and oviposition may be a factor in promoting the spread of diseases but is difficult to assess. Cicada oviposition may kill twigs, but the nymphal feeding does not appear to damage their hosts.

Bibliography: 32, 139, 161, 176, 204, 232, 233, 236, 311, 400, 415, 435, 459, 474, 505, 518, 570

Figure 31. **Spittlebugs and their allies. A.** Adult banasa stink bug, *Banasa dimidiata* (Say). **B.** Adult *Chlorochroa persimilis* Horvath. **C.** Adult pine spittlebug, *Aphrophora cribrata* (Walker). **D.** Adult Saratoga spittlebug, *A. saratogensis* (Fitch). **E.** Adult boreal spittlebug, *A. gelida* (Walker). **F.** Spittle formed by *A. cribrata* nymphs on Scots pine. **G.** Adult *Okanagana rimosa* (Say).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PITCH MIDGES (Figure 32)

Distribution, Hosts, and Importance

The jack pine resin midge, ***Cecidomyia resinicola*** (Osten Sacken), and the jack pine midge, ***C. piniinopis*** Osten Sacken, are widely distributed on jack pine and lodgepole pine in the prairie provinces. *Cecidomyia resinicola* is the most abundant species, especially on trees weakened by jack pine budworm defoliation, but neither midge is of economic importance.

Life Cycle and Appearance

Cecidomyia resinicola has one generation per year in the prairie provinces and overwinters as larvae in pitch masses on the twigs. The adults (A) are small midges, resembling mosquitoes, with a wingspan of 8–10 mm. The abdomen of newly emerged adults is pinkish orange, but the color soon fades in pinned specimens. Adults emerge in late May or early June, when the pine trees are shedding pollen. Eggs are laid singly on the bark or needles of the new shoots, usually on shoots that are only lightly resinous. The eggs hatch in about 6 days, and the young larvae burrow into pitch masses on the new shoots. Most infected masses contain only one larva, but as many as 13 larvae per pitch mass have been recorded. The larvae apparently feed on the resin, as their mouthparts are not suited to rasping the host tissue. Injury to the cambial tissue occurs nevertheless, although how this injury is caused is not known. The larvae (B, D) are bright orange-red maggots, cylindrical and tapered at both ends. They reach a length of about 4 mm at maturity. Partially developed larvae overwinter in pitch masses on the twigs (C, G). These masses become hardened and darkened by spring, but traces of orange can still be detected through the pitch. Pupation occurs within the pitch masses, but the pupae wriggle through the pitch just prior to adult emergence (E).

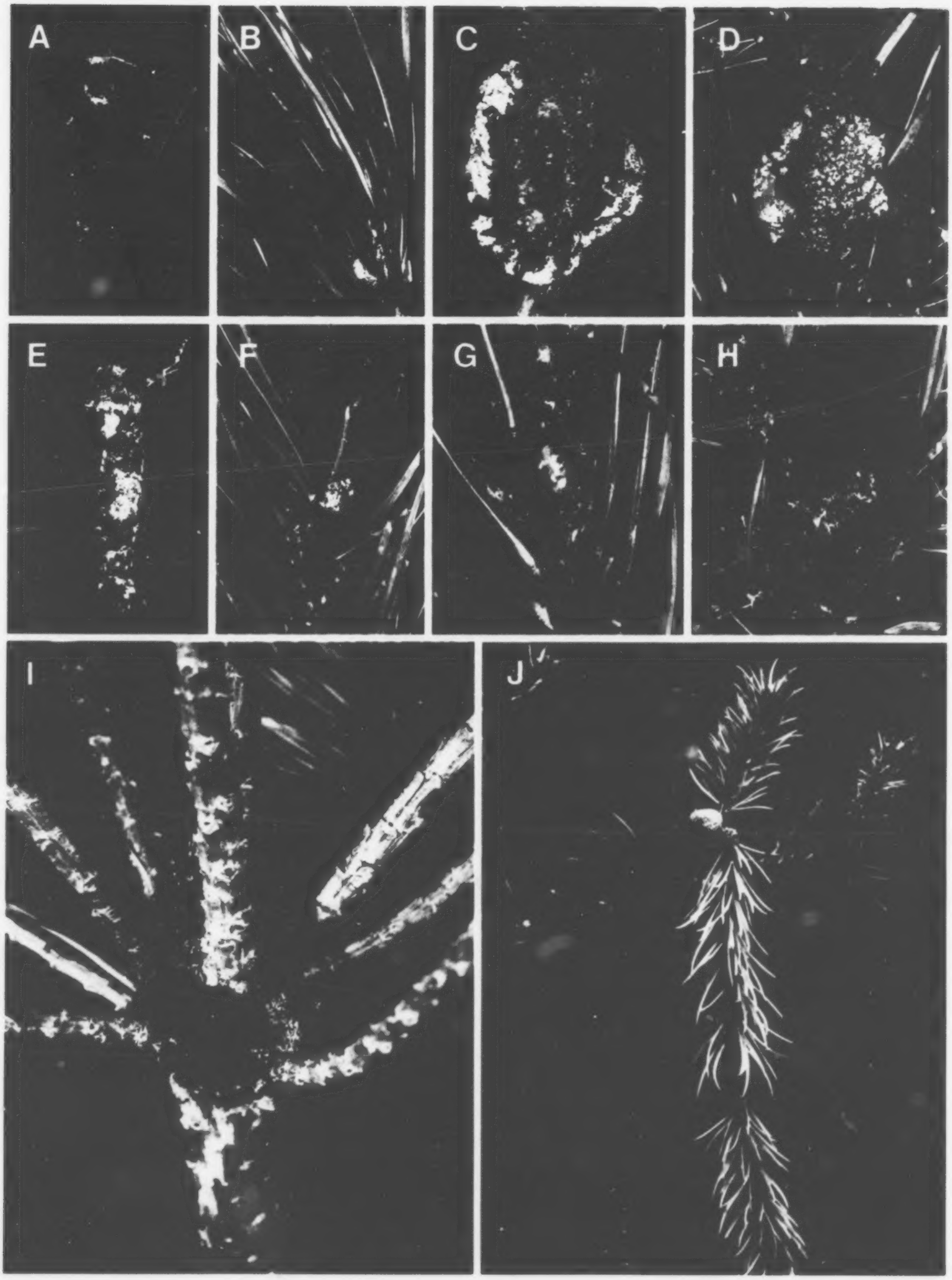
The life cycle of ***C. piniinopis*** is not fully understood, but the insect apparently has one generation per year in the prairie provinces and overwinters as larvae on the twigs. The adults (not shown) are very similar to those of *C. resinicola*, but the emergence period is 4 or 5 days later. Eggs are laid singly on the bark or foliage in late June, and the larvae feed singly in drops of pitch. The larvae are reddish orange and tapered at both ends, and they reach a length of about 5.5 mm when mature. They have prominent, paired dorsal tubercles, with another pair of smaller tubercles between them, on each of the first seven abdominal segments. The corresponding tubercles on *C. resinicola* are absent or minute. In the fall of the year the larvae are believed to enter the shoots near the base of a bud and form cavities in which they overwinter. These cavities fill with resin in early May, and the larvae vacate them. They crawl to 1-year-old shoots, where they spin whitish cocoons on the needles or bark in late May. Pupation occurs within the cocoons. The shoots or buds on twigs with overwintering cells usually die by early May, although some affected shoots may grow until they reach a length of about 50 mm in early June. These shoots have a characteristic bend.

Damage

Cecidomyia resinicola feeding kills about 75% of the affected shoots (F), but infestations are rarely severe enough to affect radial increment. Height growth on young trees may be adversely affected, however, if the infestation is severe and the leaders are killed. ***Cecidomyia piniinopis*** has never been abundant enough to cause any significant growth loss.

Bibliography: 205, 368, 465, 474, 589

Figure 32. **The jack pine resin midge, *Cecidomyia resinicola* (Osten Sacken). A.** Adult *C. resinicola*. **B.** *C. resinicola* larva. **C.** Pitch masses on jack pine containing *C. resinicola* larvae. **D.** Pitch masses opened to show *C. resinicola* larvae within. **E.** *C. resinicola* pupal cases protruding from resin masses. **F.** Jack pine twig killed by *C. resinicola*. **G.** Jack pine twigs infested with *C. resinicola*.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PITCH BLISTER MOTHS (Figure 33)

Distribution, Hosts, and Importance

Eight species of blister moths, belonging to the genus *Petrova*, occur on various pines in North America, but only two species have been recorded in the prairie provinces. The northern pitch twig moth, ***P. albicapitana*** (Busck), attacks jack pine, lodgepole pine, and Scots pine throughout the region. It is primarily a pest of young trees, but older trees are also infested to a lesser degree. ***Petrova metallica*** (Busck) attacks lodgepole pine in the Cypress Hills in Saskatchewan and Alberta and in the high foothills and mountain parks in Alberta. It is also primarily a pest in regeneration stands, although mature stands are lightly infested. It was considered to be a rare species for many years, but recent studies have shown that it is relatively abundant at elevations above 1000 m.

Life Cycle and Appearance

Petrova albicapitana has a 2-year life cycle, and adults emerge from early June to mid-July. Broods are not synchronized, and adults are present each year. The moths have a wingspan of 16-23 mm. The fore wings are reddish brown, speckled in black, with whitish or grayish bands (E). The hind wings are gray. Eggs are laid near the base of terminal buds. The young larvae excavate a cavity in the cortex tissue of the host and begin feeding. The severed pitch canals cause a copious flow of pitch. The larvae spin a layer of silk over the cavity and combine the pitch and frass to form a small blister in which they overwinter. They resume feeding early in the spring and produce a new nodule similar to the overwintering one (F). In early June the larvae move down the branch or terminal to a new location, usually to a crotch, where they form a new nodule (H, I). The larger blisters are also lined with silk and may reach a diameter of 20 mm by the end of the second summer. The larvae range in color from pale yellow to orange-brown, with reddish brown heads and thoracic shields. They lack any characteristic markings and reach a length of 15-17 mm when fully grown. Larvae feed in the cambial area, partially girdling the twig or terminal (G). The larvae feed for 2 or 3 weeks early in the spring of the 3rd year, then pupate in the pitch mass. Adults emerge about 3 weeks later.

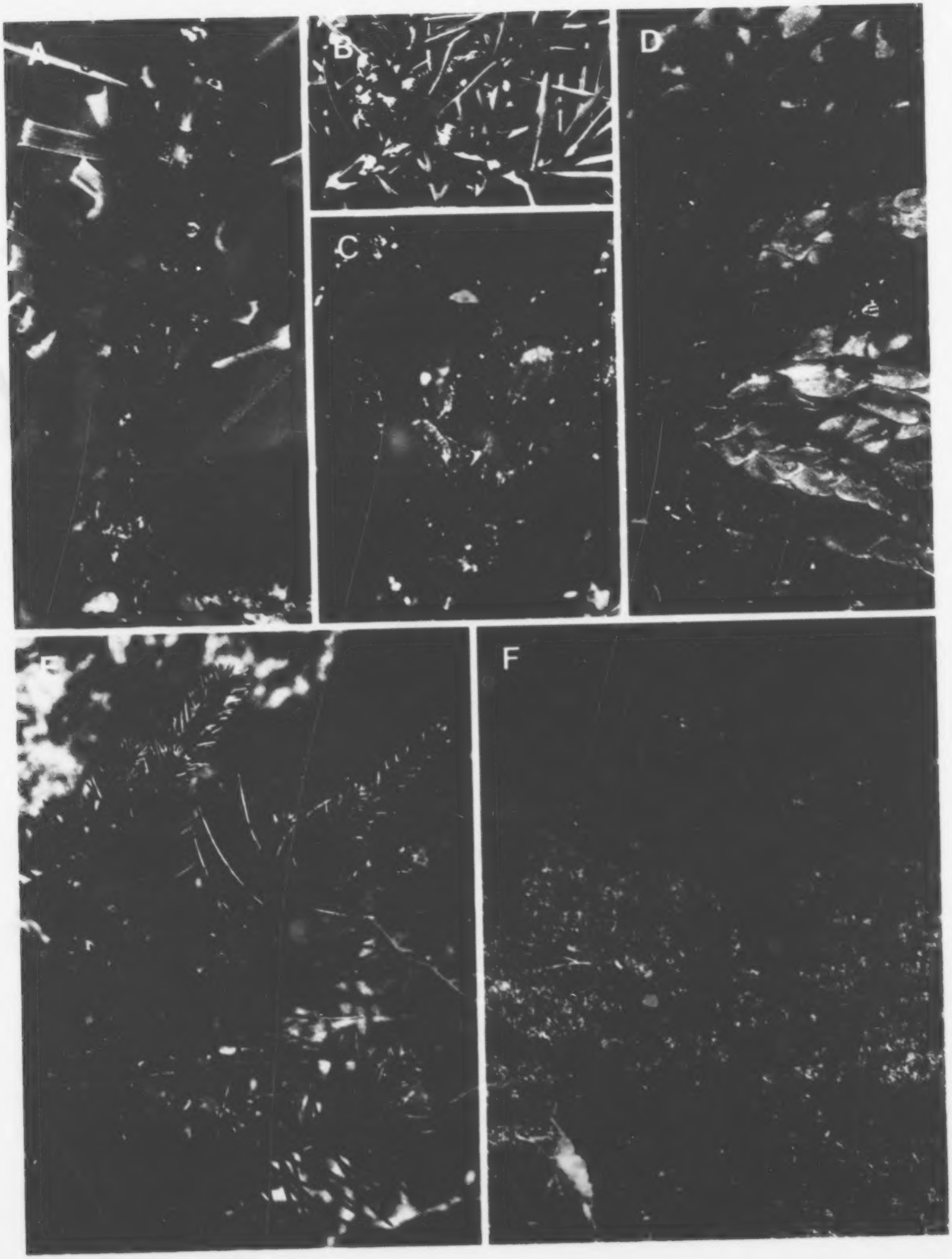
Petrova metallica has a similar life history in the prairie provinces, although it is believed to have a 1-year life cycle farther south. Adults in the prairie provinces are a dark metallic gray (A) and have a wingspan of 15-24 mm. First-year damage is very inconspicuous (B); 2nd-year nodules are mainly internodal on the branches and tend to have a rough appearance (D). The larvae, which resemble those of *P. albicapitana*, bore into the stem to feed primarily on the pith and xylem (C). They maintain a channel to the nodule and continue to enlarge it by incorporating pitch and frass.

Damage

The feeding of ***P. albicapitana*** seldom girdles the stem completely, even when there are several nodules at the same node (I). The injury weakens the stem, however, and breakage may occur later (J). Repeated attacks may cause serious stem deformities. The tunneling of ***P. metallica*** also weakens the twigs. It is not unusual to find their nodules at the ends of branches, the remainder of the twig having broken off in a windstorm. Such injury causes little damage to the tree, however, because the nodules are mainly on the branches.

Bibliography: 139, 149, 203, 351, 410, 581, 645

Figure 33. Pitch blister moths. A. Adult *Petrova metallica* (Busck). **B.** First-year *P. metallica* damage. **C.** Larva at entrance to *P. metallica* tunnel (nodule removed). **D.** Late-instar *P. metallica* nodule. **E.** Adult northern pitch twig moth, *P. albicapitana* (Busck). **F.** Early-instar *P. albicapitana* nodule. **G.** *P. albicapitana* feeding damage (nodule removed). **H.** Late-instar *P. albicapitana* nodule. **I.** Several *P. albicapitana* nodules on main stem. **J.** Lateral broken following *P. albicapitana* feeding.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SOFT SCALES (Figure 34)

Distribution, Hosts, and Importance

Several species of soft scales attack various coniferous trees in the prairie provinces. The pine tortoise scale, ***Toumeyella parvicornis*** (Cockerell), is an eastern species whose range extends into southeastern Manitoba. Its principal host is jack pine, but Scots pine and red pine are also attacked. Infestations are usually localized but can become severe. The spruce bud scale, ***Physokermes piceae*** (Schrank), is an introduced species that attacks various spruces and has spread westward into Alberta and the Northwest Territories. Heavy infestations have occurred in the Maritimes, but none have so far been reported here. The North American fruit lecanium, ***Parthenolecanium cerasifex*** (Fitch), is one of a group of closely related species that attacks eastern white cedar. Others in the group are the European fruit lecanium, ***P. corni*** (Bouché), primarily a pest of broad-leaved trees (Fig. 105) that is occasionally found on eastern white cedar, and the Fletcher scale, ***P. fletcheri*** (Cockerell), which attacks eastern white cedar and juniper. None of them have been a problem in this area.

Life Cycle and Appearance

Toumeyella parvicornis has one generation a year and overwinters as half-grown dark brown or black female scales that become shriveled and appear to be dead. Development resumes in mid-May. The scales are oval in shape and are strongly convex (A). When fully grown they are about 6 mm long and are reddish brown in color with black markings. Egg development begins in early June, and by mid-June 500 or more eggs are floating in fluid that fills the body cavity. Nymphs emerge from the genital aperture of the female in late June. They spend a short time under the scale, then disperse in search of feeding sites (C). Most nymphs find feeding sites by early July. Male scales are small and elongate, whitish in color, and fully developed after 3 weeks of feeding. They emerge in early August and mate immediately with the still-immature females, which continue feeding until late fall. Copious amounts of honeydew are secreted by the female scales.

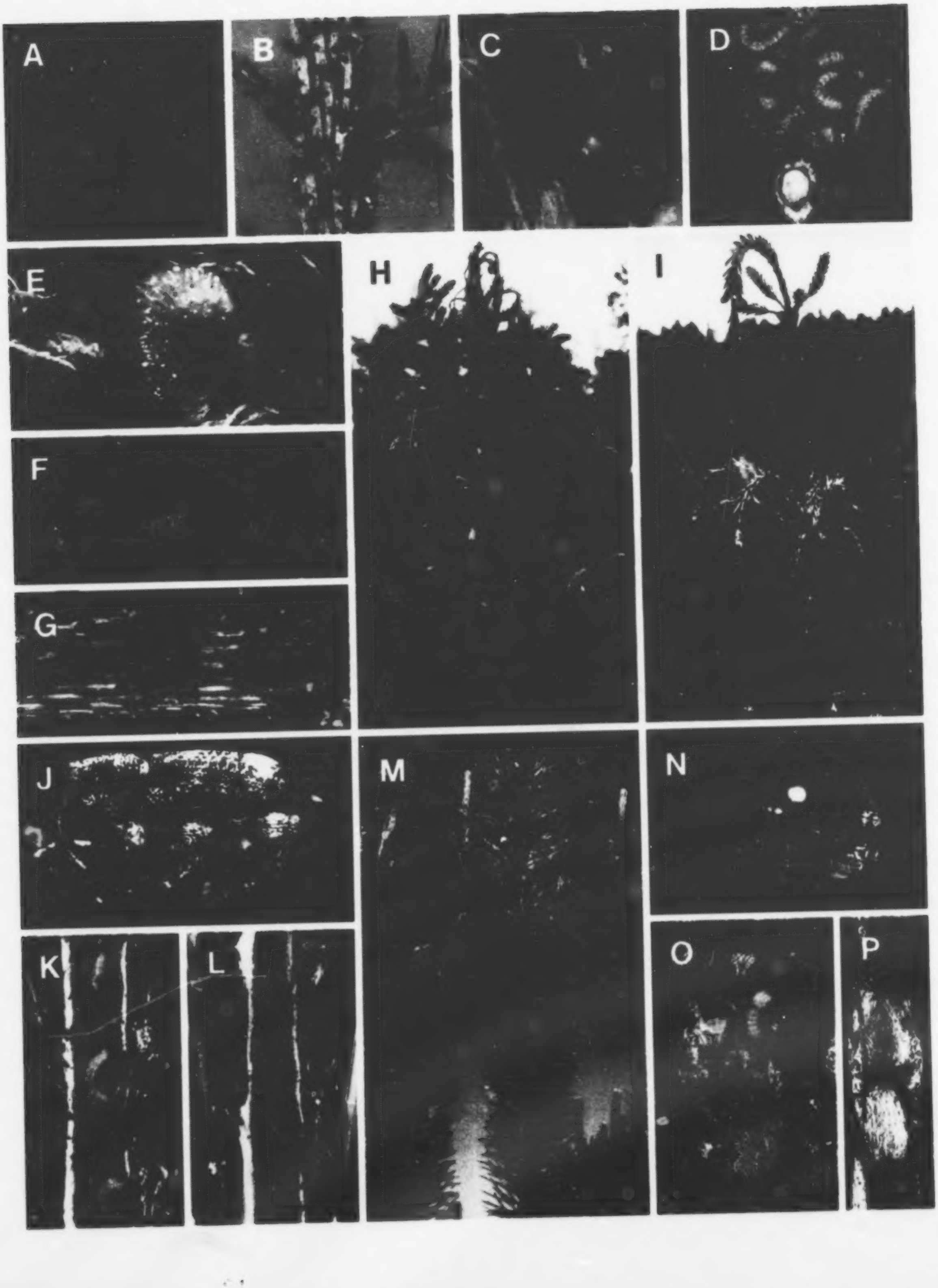
Physokermes piceae has a single generation per year and a life history similar to that of the pine tortoise scale, except that males overwinter as immature scales attached to the underside of the needles and complete their development in the spring. Most female scales settle near the bases of the smaller twigs (B). They are reddish brown and hemispherical, resembling buds. ***Parthenolecanium cerasifex*** is variable in size and shape and may be almost flat to nearly hemispherical (D). The scales may measure up to 10 mm in length and are brown in color, often with darker markings. The life history is similar to that of the pine tortoise scale. ***Parthenolecanium corni*** and ***P. fletcheri*** are so similar in appearance to *P. cerasifex* that some authorities question whether they are separate species.

Damage

Scale insects secrete copious amounts of honeydew, and unless attended by ants, the trees often become heavily infected with sooty mold, which gives the branches a blackish appearance (E). The pine tortoise scale usually attacks small trees (F), but pole-sized trees are sometimes attacked. Severe infestations can kill branches or trees in 1 or 2 years. The other scale species are capable of causing serious damage but have not yet done so in the prairie provinces.

Bibliography: 139, 180, 203, 297, 432, 460, 468, 475, 477

Figure 34. Soft scales. A. Pine tortoise scale, *Toumeyella parvicornis* (Cockerell), on jack pine. **B.** Spruce bud scale, *Physokermes piceae* (Schrank), on white spruce. **C.** *T. parvicornis* crawlers. **D.** North American fruit lecanium, *Parthenolecanium cerasifex* (Fitch), on eastern white cedar. **E.** Sooty mold on branch heavily infested with *T. parvicornis*. **F.** Young jack pine infested with *T. parvicornis*.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TERMINAL WEEVILS AND THEIR ALLIES (Figure 35)

Distribution, Hosts, and Importance

Several species of weevils in the genus *Pissodes* attack conifers in the prairie provinces. Separation of the various species has been difficult in the past, but studies of the chromosomes and host associations have assisted in their identification. The white pine weevil, ***Pissodes strobi*** (Peck), attacks most species of pine and spruce in the region. The lodgepole terminal weevil, ***P. terminalis*** Hopping, attacks jack pine and lodgepole pine. Both species are important pests, especially in young stands. Older trees are also attacked, but the damage is less evident. The northern pine weevil, ***P. approximatus*** Hopkins, occurs mainly on red and Scots pines in Manitoba and on lodgepole pine in Alberta. It may become a serious pest in Christmas tree plantations. The Yosemite bark weevil, ***P. schwarzi*** Hopkins, has been observed feeding on lodgepole pine in Alberta but is of no economic importance.

Life Cycle and Appearance

Pissodes strobi has one generation per year and overwinters as sexually immature adults in the duff beneath the trees. They are dark brown or black weevils about 4–6 mm long (A). The head has a slender curved snout, and the elytra are usually patchily marked with brown and white scales. The adults emerge in the spring and begin feeding, leaving wounds on the tender bark (B) below the dormant terminal buds. Eggs (C) are deposited in the feeding punctures, and the larvae hatch in about 10 days. They are white, legless grubs with light brown heads. The larvae enlarge the feeding punctures, then start feeding in the cambial area, working towards the base of the tree. After feeding individually for a short period, the larvae congregate into a feeding ring, thus girdling the stem (D). Fully fed larvae (E) construct pupal cells of wood tissue in shallow cavities excavated in the xylem of larger stems (F). In small stems the larvae burrow into the pith to pupate. Adults bore holes through the bark (G) and emerge in late August or early September. They feed for a brief period, then enter the duff to hibernate.

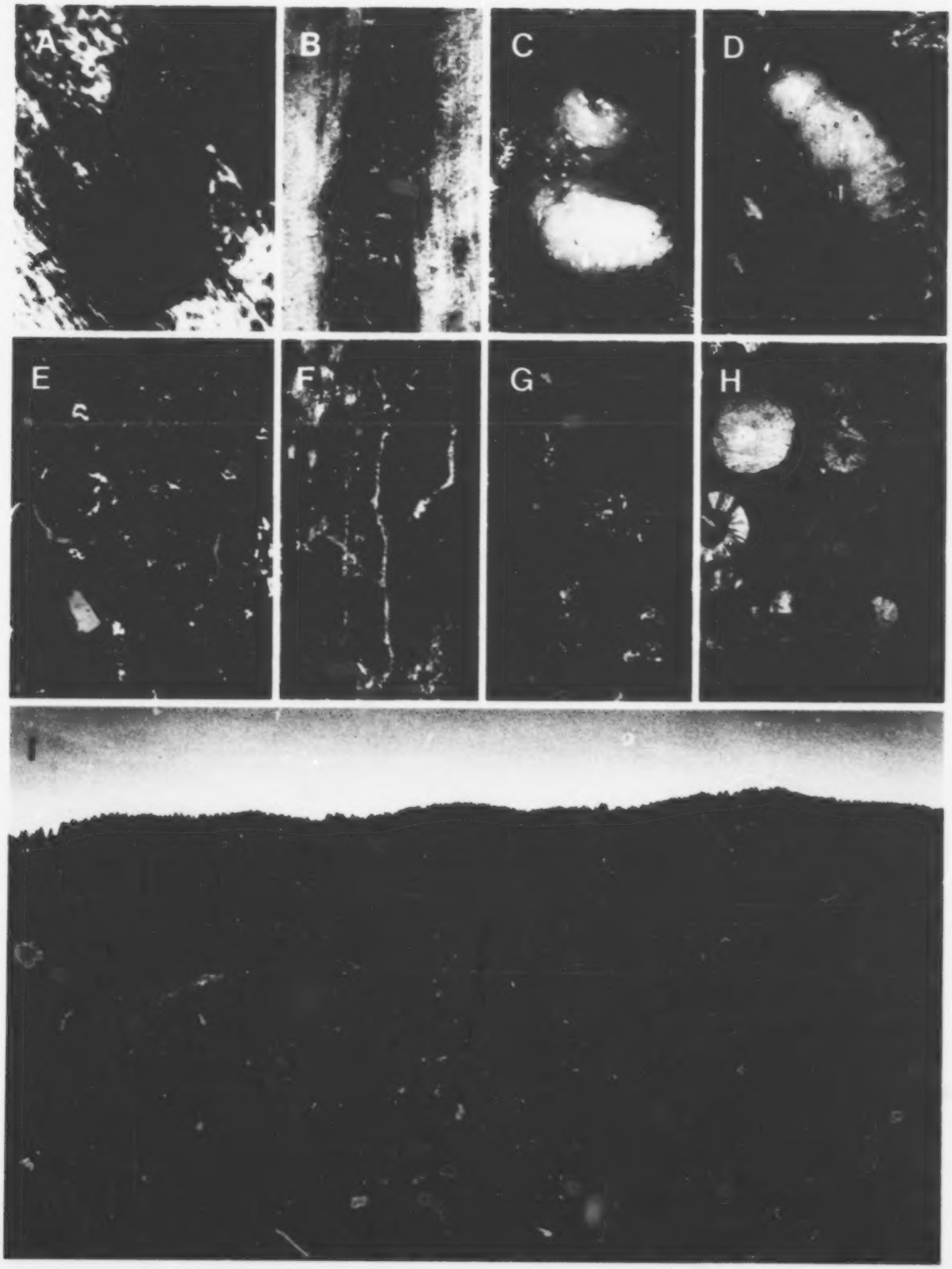
Pissodes terminalis is believed to have a life history similar to that of the white pine weevil, although the insect may overwinter in the larval stage at higher elevations. The adults are small brown weevils (J) about 4–6 mm long and are heavily marked with white scales. The adults emerge in late spring and deposit their eggs in feeding punctures at intervals along the elongating terminals on lodgepole pine or near the base of the terminal on jack pine. Larvae enlarge these feeding punctures, then move individually towards the apex of the developing shoot. They do not form a feeding ring. Fully fed larvae form pupal cells, mainly in the pith (K), in which pupation occurs (L). ***Pissodes approximatus*** also has a life cycle that is similar to that of the white pine weevil, except that it breeds in freshly cut stumps and logs or in the stem and branches of weakened trees. It forms pupal cells similar to those of the white pine weevil. Little is known about the life history of ***P. schwarzi*** in Alberta, except that it has one generation per year and breeds in the bole and root collar of the host tree. The adult (N) is reddish brown to dark brown and is about 5–7 mm long. The larvae (O) and pupal cells (P) resemble those of *P. strobi*.

Damage

Attacks by ***P. strobi*** kill or seriously injure the leaders of spruce (H) and pine (I), especially in open-growing stands. Two or more years' growth are affected, and repeated attacks cause crooked or bushy trees of low value. A considerable loss in height growth also occurs, thus reducing timber volume at maturity. ***Pissodes terminalis*** causes similar damage, except that it is less severe (M). ***Pissodes approximatus*** may become a serious pest in Christmas tree plantations by preventing a second harvest or by damaging residual trees.

Bibliography: 54, 139, 142, 203, 243, 280, 414, 515, 536, 548, 555, 556

Figure 35. Terminal weevils and their allies. A. Adult white pine weevil, *Pissodes strobi* (Peck). **B.** *P. strobi* adult feeding punctures on spruce. **C.** *P. strobi* egg. **D.** Late-instar *P. strobi* larvae. **E.** Mature *P. strobi* larva and pupal cell. **F.** Cluster of *P. strobi* pupal cells. **G.** *P. strobi* adult emergence holes. **H.** White spruce leader killed by *P. strobi*. **I.** Jack pine leader killed by *P. strobi*. **J.** Adult lodgepole terminal weevil, *P. terminalis* Hopping. **K.** Mature *P. terminalis* weevil larvae in pupal cells. **L.** *P. terminalis* weevil pupae. **M.** Lodgepole pine leader killed by *P. terminalis* attack the previous year. **N.** Adult Yosemite bark weevil, *P. schwarzi* Hopkins. **O.** *P. schwarzi* larva and pupal cells. **P.** *P. schwarzi* pupal cells.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THE MOUNTAIN PINE BEETLE (Figure 36)

Distribution, Hosts, and Importance

The mountain pine beetle, ***Dendroctonus ponderosae*** Hopkins, is one of the most destructive forest pests in western Canada. Lodgepole pine is its principal host in the prairie provinces, although western white pine, limber pine, Scots pine, and other pines are also attacked. An infestation in the early 1940s extended as far north as Banff National Park, but no infestations occurred east or north of there. It was thought until recently that weather conditions in most of Alberta were too severe for the insect to become a problem. The recent outbreak in the southern part of the province has clearly demonstrated that the climatic barrier, if it exists, is rather tenuous. Although it still appears that most of the lodgepole pines on the east slopes of the Rocky Mountains are relatively safe, it is impossible to be categorical in making such statements. An amelioration of weather conditions (milder winters, hotter and drier summers) could rapidly change the situation.

Life Cycle and Appearance

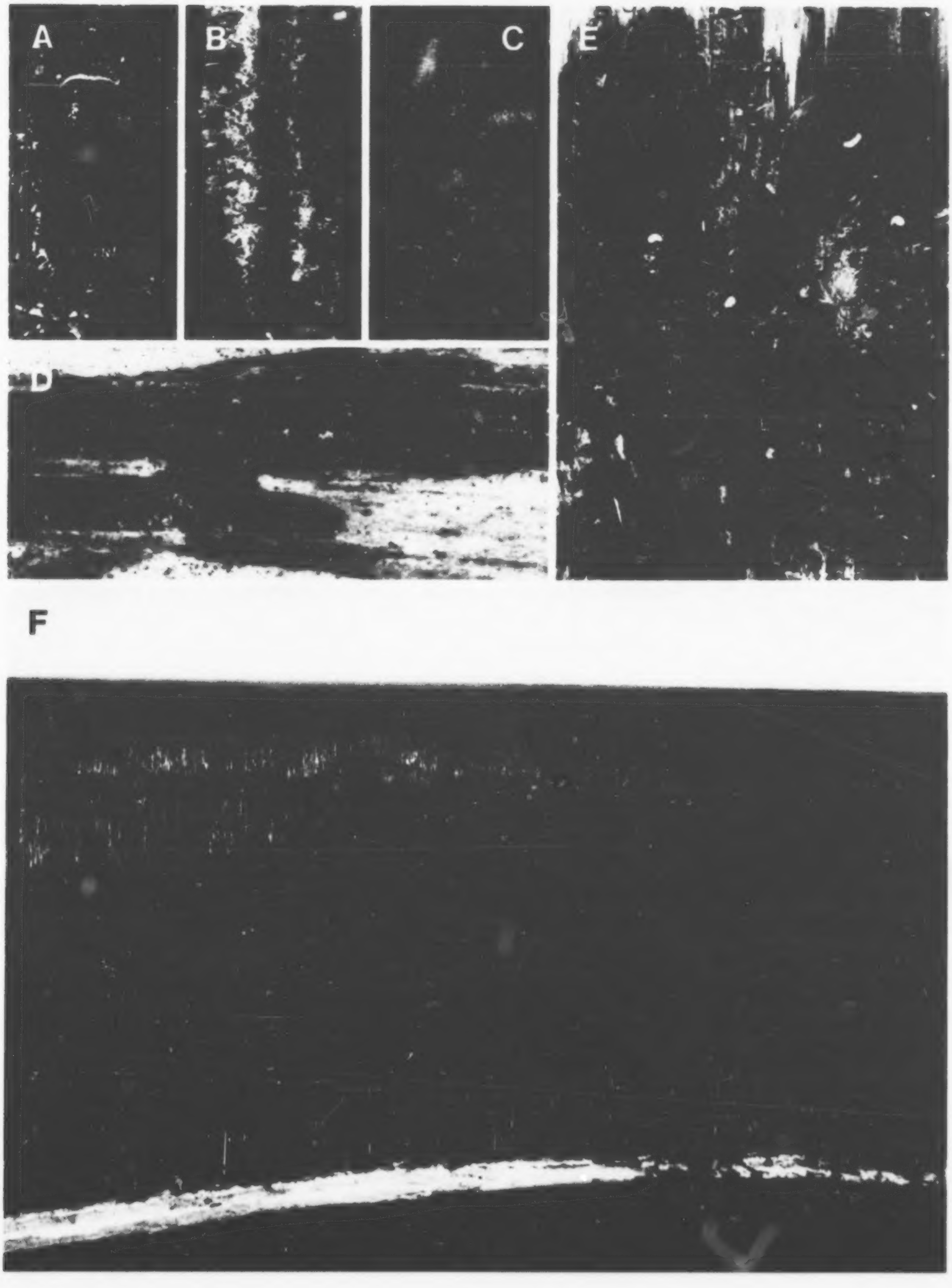
Dendroctonus ponderosae normally has one generation a year. Both larvae and adults overwinter, but the adults are less cold hardy, and the bulk of the overwintering population is larvae. The adult beetles (A) are black, stout-bodied insects that measure between 4.0 and 7.5 mm in length. They bore small, round emergence holes through the bark (G) and attack new host trees in midsummer, often causing pitch tubes to form (E). The females excavate long vertical galleries, often with a crook at the base, in the inner bark (F) and secrete pheromones that attract the males. The white eggs are deposited singly in groups of niches excavated on alternate sides of the gallery as it is being constructed (B). The larvae are white, legless grubs with brown heads (C), and they bore lateral galleries (F). The larvae overwinter in the galleries and resume feeding in the spring. The pupae are white and exarate (D) and rest in pupal chambers.

Damage

Dendroctonus ponderosae attacks the larger trees in the stand first. Successful attack usually results in the death of the tree due partly to the girdling effect of the larval galleries and partly to the blue-stain fungi (C, H) that the beetles carry. The fungal mycelia quickly proliferate throughout the sapwood, plugging the vessels. Foliage discoloration usually occurs in the spring of the year following attack (I).

Bibliography: 105, 203, 265, 274, 359, 373, 493, 554, 652

Figure 36. The mountain pine beetle, *Dendroctonus ponderosae* Hopkins. A. Adult *D. ponderosae*. **B.** *D. ponderosae* female and eggs in gallery. **C.** *D. ponderosae* larva. **D.** *D. ponderosae* pupa. **E.** Pitch tubes caused by *D. ponderosae*. **F.** *D. ponderosae* adult and larval galleries. **G.** *D. ponderosae* adult emergence holes. **H.** Logs infected with blue-stain fungi. **I.** Lodgepole pine trees killed by *D. ponderosae*.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SPRUCE BEETLES (Figure 37)

Distribution, Hosts, and Importance

Two species of *Dendroctonus* bark beetles attack spruce in this area. The spruce beetle, ***D. rufipennis*** (Kirby), is a transcontinental North American species that occurs principally on white spruce and Engelmann spruce in the prairie provinces. The beetles normally breed in fallen trees, stumps, or slash and are often present in small numbers over wide areas. Most or all outbreaks on living trees originate from large supplies of nearby logging slash, blowdown, or dead standing timber following fire. Devastating outbreaks have occurred throughout the west, from Arizona to Alaska, and several smaller outbreaks have been reported in Alberta and Saskatchewan. The Allegheny spruce beetle, ***D. punctatus*** LeConte, is also a transcontinental species. It attacks white spruce and black spruce and has been collected in the Cypress Hills, northern Alberta, and the Northwest Territories. Mortality of scattered trees has been reported, but no significant outbreaks have been reported.

Life Cycle and Appearance

Dendroctonus rufipennis has a 1-year life cycle in the warmer parts of its range but usually requires 2 or sometimes 3 years to complete its development in northern latitudes, at high elevations, or on north-facing slopes. The insect overwinters in the adult stage in areas where the beetles have a 1-year life cycle and in the larval and adult stages elsewhere. Most beetles in the prairie provinces probably have a 2-year cycle, although those on exposed slash or south-facing slopes may develop to the adult stage in 1 year. In western North America, only beetles that have overwintered as adults are capable of reproduction the following summer. They are stout-bodied insects, ranging in length from 4.5 to 7.0 mm. Newly emerged adult beetles are dark brown or black with reddish brown elytra (A) that become almost black as the beetles age. They attack new hosts in the spring or early summer, depending upon location. In the prairie provinces, most attacks probably occur in late May or early June. The female constructs short egg galleries in the phloem, engraving the sapwood. The galleries follow the grain in standing trees or stumps and in logs or slash (D). Eggs are deposited in either single or double irregular rows (B). Larvae tend to feed in groups in the early instars and individually as they mature (E). They are creamy-white, legless grubs with light brown heads (C), and they reach 6 or 7 mm in length when mature. Overwintering larvae resume development in the spring, pass through a brief pupal stage, and transform into adults. Adults emerge from standing trees in August or September, move to the base of the trees, reenter the bark, and hibernate. Adults in windfall or slash remain under the bark and do not emerge until the following spring.

Dendroctonus punctatus adults (not shown) closely resemble those of *D. rufipennis*, except that they are brown rather than black when mature. Little is known about their biology, but it is believed that their life cycle requires 2 or 3 years in northern areas. The larvae feed in a group to excavate flat cavities in the phloem. The insect overwinters as partly grown larvae and as adults.

Damage

Dendroctonus rufipennis is capable of attacking and killing standing timber (F), especially if large numbers of beetles are present following fires, windstorms, or logging operations. The effect of larval feeding is further enhanced by blue-stain fungi transmitted by the beetles. The amount of mortality attributable to ***D. punctatus*** is too low to be a problem, especially when most of it occurs in remote areas.

Bibliography: 11, 61, 159, 160, 203, 313, 500, 501, 655

Figure 37. The spruce beetle, *Dendroctonus rufipennis* (Kirby). A. Adult *D. rufipennis*. **B.** *D. rufipennis* eggs. **C.** *D. rufipennis* larvae. **D.** *D. rufipennis* adult galleries. **E.** Adult and larval *D. rufipennis* galleries. **F.** White spruce stand damaged by *D. rufipennis*.

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THE EASTERN LARCH BEETLE AND ITS ALLIES (Figure 38)

Distribution, Hosts, and Importance

There are several species of *Dendroctonus* besides the mountain pine beetle and the spruce beetle that cause damage in the region. The eastern larch beetle, ***D. simplex*** LeConte, attacks tamarack that have been weakened by larch sawfly defoliation or some other environmental factor such as flooding. Localized infestations have been noted in Manitoba and Saskatchewan. The Douglas-fir beetle, ***D. pseudotsugae*** Hopkins, attacks Douglas-fir, but the limited occurrence of its host restricts its importance in this region. The lodgepole pine beetle, ***D. murrayanae*** Hopkins, attacks the lower bole and root crown of primarily overmature or weakened lodgepole or jack pine, causing localized infestations. The red turpentine beetle, ***D. valens*** LeConte, attacks the lower bole of 40 or more species of conifers, but no major outbreaks have been reported.

Life Cycle and Appearance

Identification of the various species of *Dendroctonus* is difficult because of size and color variation within species and the lack of good external morphological differences between species. Host and gallery pattern are perhaps the best criteria for provisional field identification.

Dendroctonus simplex has as many as three generations per year and overwinters primarily as sexually immature teneral adults. They are 3.5–5.0 mm long and are typically reddish brown, although some specimens are almost black (A). Adults emerge in May and June and, following successful attack, construct long sinuous galleries in the middle bole of the tree, primarily in the inner bark. Eggs are deposited in the sides of the adult galleries, and the grublike larvae (B) tunnel laterally from the main galleries (C).

Adult ***D. pseudotsugae*** (F) are morphologically very similar to *D. simplex* but are usually larger, measuring between 4.5 and 7.0 mm in length. The life history is also similar, although the adult galleries tend to be straighter (I, J), and there is only one generation annually.

Adult ***D. murrayanae*** (H) are very similar to the spruce beetle, *D. rufipennis* (Fig. 37), but can be separated from them on the basis of host. The overwintering adults are between 5.0 and 7.5 mm long. They emerge in June and attack the root crown or lower bole of the host tree, causing prominent pitch tubes to form (K). Following successful attack the adults construct irregular vertical galleries (E). Groups of eggs are laid in pockets excavated off the main galleries and separated from them by packed frass. The larvae feed laterally in groups, then turn up or down to form broad, L-shaped tunnels. There is one generation annually.

Dendroctonus valens probably overwinters in both the adult and larval stages because of slow development in northern areas. Complete development may take as long as 2 years in cold areas. The adults are one of the largest *Dendroctonus* beetles, measuring between 5.5 and 9.0 mm in length. The body is usually reddish brown (G), but some dark specimens occur. Egg galleries are variable in shape, but tend to resemble an inverted letter J, and are constructed primarily in stumps or weakened trees. Eggs are laid in masses along alternate sides of the galleries and are packed in frass. The larvae feed in groups, forming cavities packed with reddish frass.

Damage

All of these bark beetles are capable of killing trees (D) but, with the possible exception of ***D. pseudotsugae***, are not usually considered to be major pests. They are more likely to be a problem if weakened or damaged trees occur fairly extensively in areas, but isolated trees may also be attacked.

Bibliography: 14, 61, 139, 143, 201, 228, 397, 398, 399, 490, 535, 566, 655

Figure 38. The eastern larch beetle, *Dendroctonus simplex* LeConte, and its allies. A. Adult *D. simplex.** **B.** *D. simplex* larvae.* **C.** Adult and larval galleries of *D. simplex.** **D.** Tamarack killed by *D. simplex.** **E.** Adult lodgepole pine beetle, *D. murrayanae* Hopkins, galleries. **F.** Adult Douglas-fir beetle, *D. pseudotsugae* Hopkins. **G.** Adult red turpentine beetle, *D. valens* LeConte. **H.** Adult *D. murrayanae.* **I.** *D. pseudotsugae* adult in gallery. Note eggs along edge of gallery. **J.** Adult and larval galleries of *D. pseudotsugae.* **K.** Pitch tubes caused by *D. murrayanae* attack.

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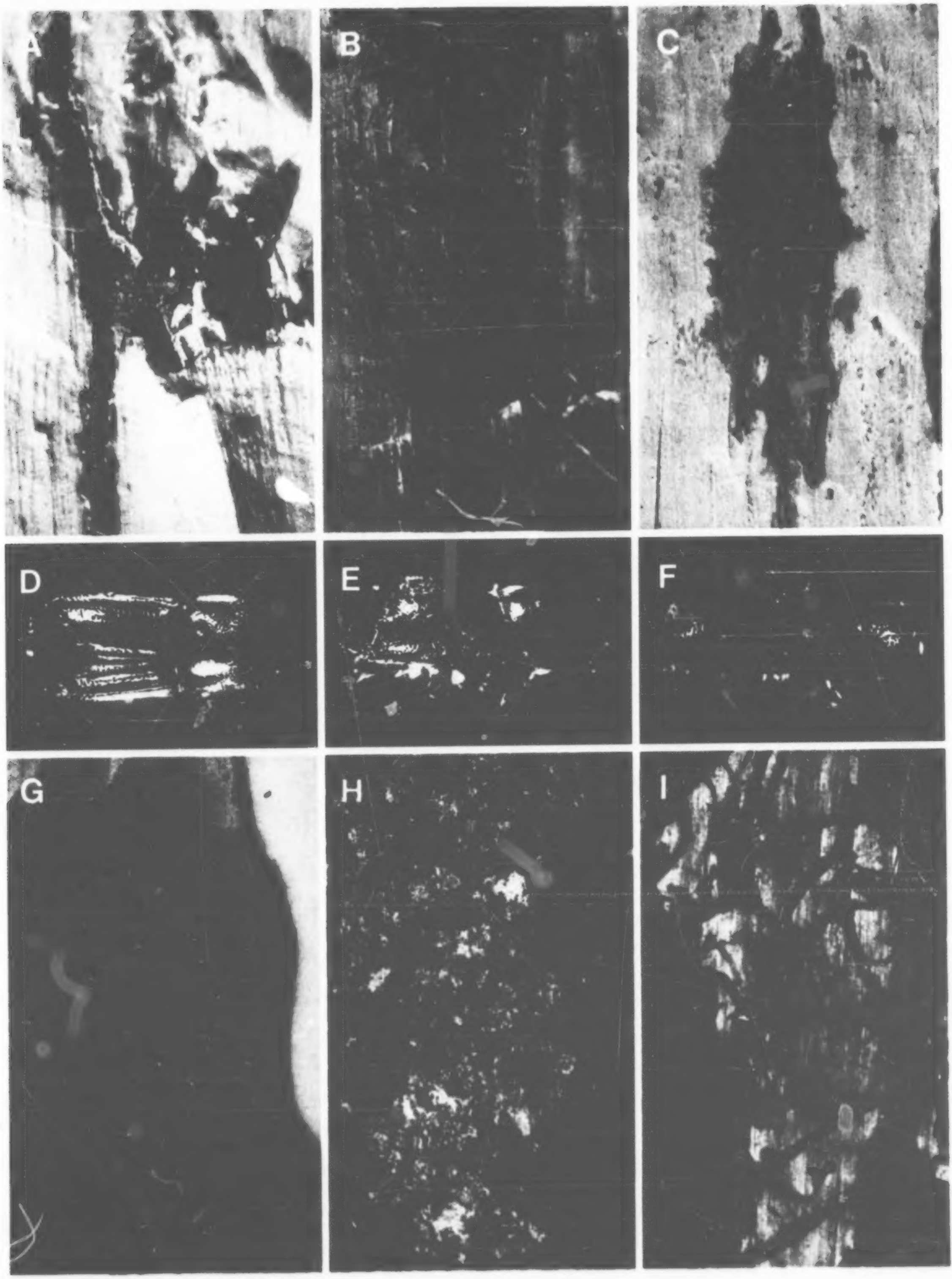
* Photograph courtesy of the Canadian Forestry Service—Maritimes.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IPS BARK BEETLES (Figure 39)

Distribution, Hosts, and Importance

There are many species of bark beetles whose effects on the forest are largely beneficial because they breed in slash and windfall, thus helping to speed the removal of litter from the forest floor. Most species of the genus ***Ips*** normally fall into this category, and the three most common species in the prairie provinces usually breed in large limbs or small trunks of dead or dying trees.

The pine engraver, ***I. pini*** (Say), is the most abundant of the three species. It is very widely distributed throughout North America, where it attacks most species of pine. Spruce is also occasionally attacked. Infestations are normally confined to dead wood, but the insect is capable of successfully attacking apparently healthy trees, especially during periods of spring drought. These attacks are usually limited to small trees or to the tops of larger ones and are particularly likely to occur if large amounts of slash or windfall are present. Infestations in live trees are usually short-lived.

The other two common *Ips* species are usually considered to be secondary insects but will occasionally attack weakened living trees. The northern spruce engraver, ***I. perturbatus*** (Eichhoff), is very widely distributed and is found wherever its host, white spruce, occurs. The northern engraver, ***I. borealis*** Swaine, is the least common of the three species. It also has a wide distribution and attacks white spruce, where it can often be found in association with *I. perturbatus*.

Life Cycle and Appearance

Identification of bark beetles requires a specialist, but the genus *Ips* can be recognized fairly accurately by the elytral declivity, which is concave and has three to six spines on each lateral margin.

All three species discussed here have four spines on each side of the elytral declivity and range in color from light brown to almost black, depending upon age. ***Ips borealis*** adults (E) are the smallest of the three, ranging from 3.0 to 3.6 mm in length. Their galleries are also slender (A, B, C). ***Ips perturbatus*** adults (D) are 4.2–4.8 mm long, and the adult galleries are relatively large (G). ***Ips pini*** adults (F) are intermediate in size, measuring 3.5–4.5 mm in length. Their galleries normally follow the grain but may run in any direction in heavy infestations on fallen trees (I).

All of the above *Ips* species have similar life histories, as far as is known. Young adults feed on the phloem tissue for several weeks, then emerge from the bark in September or October and hibernate in the duff. Immature stages remaining in the bark rarely survive the harsh winter temperatures of the prairie provinces.

Hibernating adults become active in early spring. Males cut entrance holes through the bark, then construct nuptial chambers large enough to accommodate several females. Successful males mate with the females that have joined them. The females then begin constructing galleries in the phloem. These galleries initially radiate out from the nuptial chambers but later tend to follow the grain of the wood. Eggs are deposited in niches cut at intervals along these galleries. Larvae tend to feed at right angles to the egg galleries, enlarging their galleries as they grow. Their feeding is mainly in the phloem.

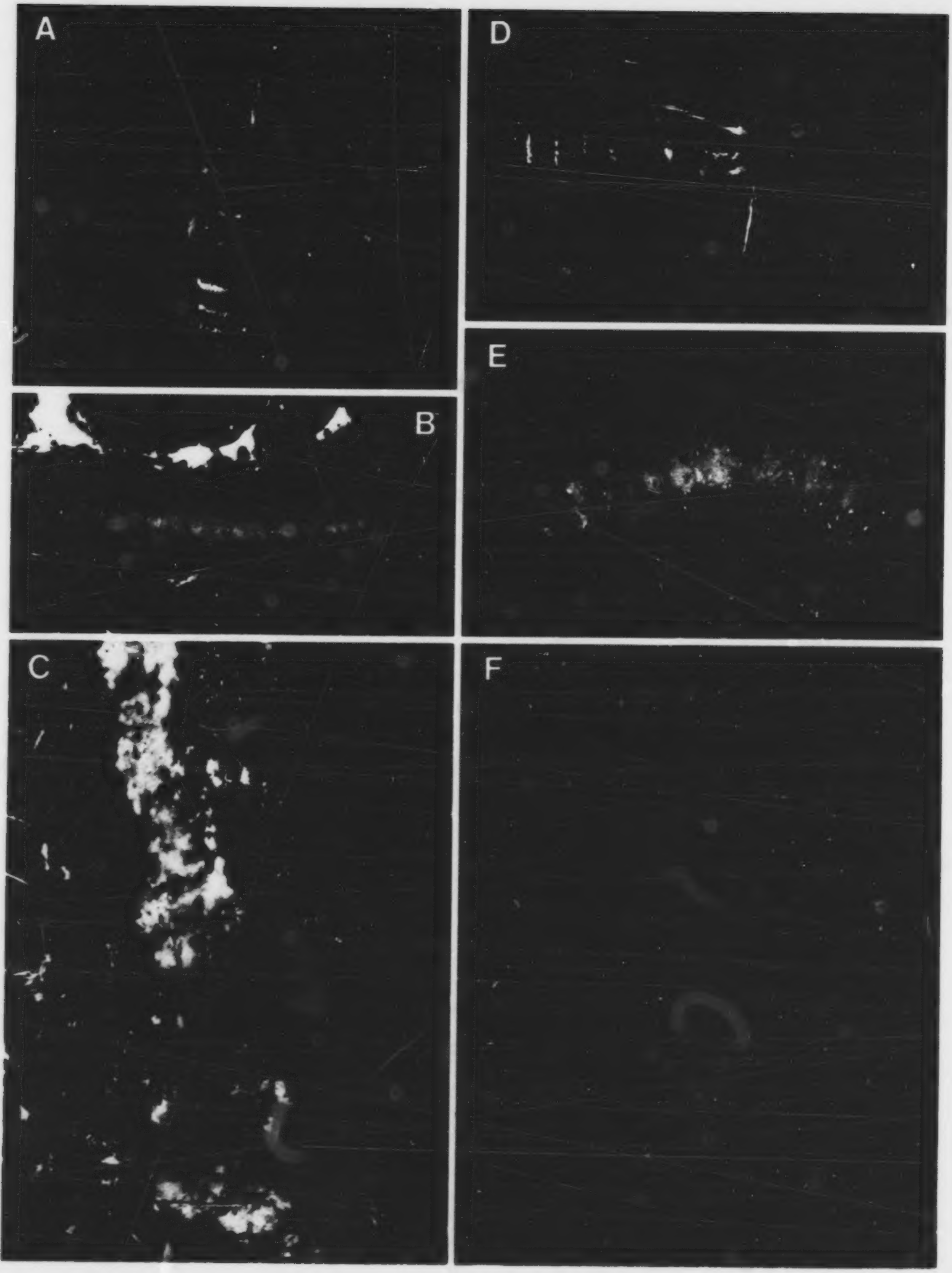
Ips pini and ***I. perturbatus*** females are known to emerge from the bark after laying their first batch of eggs. Many of these females establish a second, smaller brood. *Ips pini* may have a second, single-brood generation in many parts of the prairie provinces. Some *I. perturbatus* females may live more than one year, but they do not produce many eggs the second summer.

Damage

Ips bark beetle adults keep their galleries relatively free of borings. Consequently, piles of sawdust on the trunk (H) or branches are usually the first sign of attack. Small living trees, or the tops of larger ones, can be killed by moderate infestations. Such infestations are most likely to occur in young stands adjacent to large clear-cut operations or in residual trees in stands that have been thinned extensively.

Bibliography: 61, 139, 203, 216, 275, 276, 277, 278, 279, 329, 330, 467, 498, 499, 571

Figure 39. *Ips* bark beetles. A. Close-up view of the northern engraver, *I. borealis* Swaine, nuptial chamber and female galleries. **B.** Egg niches along *I. borealis* female gallery. **C.** *I. borealis* nuptial chamber and female galleries. **D.** Adult northern spruce engraver, *I. perturbatus* (Eichhoff). **E.** Adult *I. borealis*. **F.** Adult pine engraver, *I. pini* (Say). **G.** *I. perturbatus* adult and larval galleries. **H.** Sawdust on pine trunk resulting from *Ips* species attack. **I.** *I. pini* adult and larval galleries.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PITCH MOTHS (Figure 40)

Distribution, Hosts, and Importance

Larval feeding by three species of clearwing moths in the genus *Synanthedon* cause conspicuous pitch masses to form on the stems of various conifers. The sequoia pitch moth, ***S. sequoiae*** (Hy. Edwards), is a western species whose range extends into Kootenay National Park and possibly southwestern Alberta. It attacks lodgepole pine in this region. The Douglas-fir pitch moth, ***S. novaroensis*** (Hy. Edwards), is another western species whose range extends into central Alberta. Spruce is its principal host, but pine and Douglas-fir are also infested if they are growing near spruce. The pitch mass borer, ***S. pini*** (Kellicott), is an eastern species whose range may extend into southeastern Manitoba. Its principal host is white pine, but white spruce and other pines are also attacked. None of these insects are of economic importance in the forest, but they may become pests on open-growing ornamentals, particularly if the trees have been injured or pruned.

Life Cycle and Appearance

Synanthedon sequoiae has a 2-year life cycle; it overwinters twice in the larval stage. Pupation occurs in the spring of the 2nd year, and the short-lived adults emerge in June and July. They are clearwing moths with a wingspan of 18–30 mm. The head and thorax are black with some yellow markings, and the abdomen is black with conspicuous yellow bands that give the insect a superficial resemblance to a yellow jacket wasp (A). The females mate and lay eggs singly in bark crevices or near wounds; the latter seem to be the preferred sites. The eggs are usually scattered anywhere on the lower bole but are sometimes concentrated near the base of the trees. The larvae hatch in about 2 weeks. They burrow to the cambial area, where they construct horizontal tunnels. First-year larvae have whitish bodies with brown heads (B); the bodies of mature larvae are yellowish. Fully grown larvae are about 25 mm long. The mature larvae construct an enlarged tunnel, which they line with silk before pupating. The pupae are active and move around in this chamber, with the aid of spines. In about 1 month they force themselves about halfway through the thin pitch layer covering one end of the tunnel. The adults emerge soon afterwards. The larval feeding causes a copious flow of resin, which hardens and forms conspicuous masses on the stem. This resin spreads out from the base of trees when oviposition is concentrated on the lower bole (C).

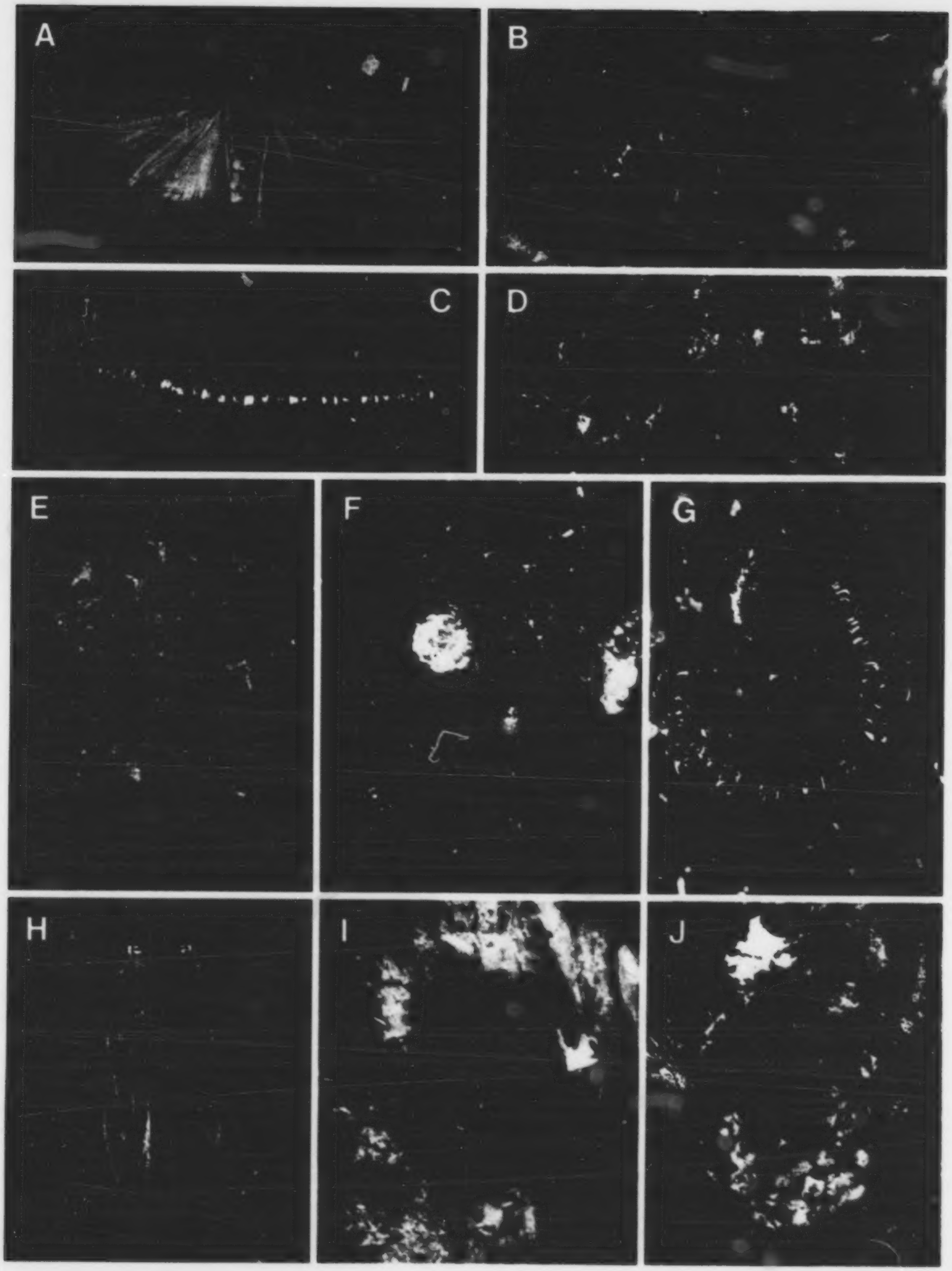
The life histories and appearance of the two other species are similar to those of *S. sequoiae*. ***Synanthedon novaroensis*** moths have black heads and thoraxes and bluish black abdomens (D). The markings are reddish orange instead of yellow. The larvae are white or creamy-white with brown heads, and they do not become yellowish at maturity (E). The pitch masses on spruces are concentrated around wounds or branch bases and are usually amorphous. Those on pines are similar, except that the pitch hardens and forms a convoluted mass (F). Attacks are spread throughout the lower crown but may occur at ground level, especially if the trees have been injured by grass-cutting equipment. ***Synanthedon pini*** adults resemble those of *S. novaroensis* but have more orange on the abdomen. Larvae are white or pink and have brown heads.

Damage

Attacks by any of the pitch moths do not usually kill the trees, although a number of infested lodgepole pine in Kootenay National Park have died. ***Synanthedon sequoiae*** probably contributed to their death, as most of the dead trees were at least partially girdled at their base. Branches and tops of ornamental white spruce in Edmonton have apparently been killed by ***S. novaroensis*** infestations.

Bibliography: 41, 78, 139, 147, 149, 168, 203, 355, 454, 477, 602

Figure 40. Pitch moths. A. Female sequoia pitch moth, *Synanthedon sequoiae* (Hy. Edwards). **B.** *S. sequoiae* larva. **C.** Pitch mass at base of lodgepole pine infested by *S. sequoiae*. **D.** Male Douglas-fir pitch moth, *S. novaroensis* (Hy. Edwards). **E.** Mature *S. novaroensis* larva. **F.** Pitch mass on lodgepole pine caused by *S. novaroensis* larval feeding.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INSECTS ASSOCIATED WITH PITCH MASSES (Figure 41)

Distribution, Hosts, and Importance

Several species of *Dioryctria* cause pitch masses to form on conifers. Many of the scanty reports on hosts, distribution, and damage for this group of insects are of questionable authenticity because both the adult and larval stages are difficult to identify, and larvae in the same species often have a variety of feeding habits.

Dioryctria banksiella Mutuura, Munroe and Ross is a recently described species that breeds in various species of rust galls on jack pine. It is found most commonly in association with the western gall rust, *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka. Little resin is produced if the galls are inactive (Fig. 13), but copious resin flow often occurs on young active galls that are on or near the main stem. Three other species of *Dioryctria* tunnel in the cambial area of pines, producing resin masses. The fir coneworm, ***D. abietivorella*** (Grote), is a widely distributed species that attacks spruce, pine, and Douglas-fir. It is primarily a pest of spruce cones (Fig. 3), but it will attack the trunks of young pine. The Zimmerman pine moth, ***D. zimmermani*** (Grote), is an eastern species whose range may extend into southeastern Manitoba. Scots pine is its preferred host, but other pines are also attacked. The western pine moth, ***D. cambiicola*** (Dyar), is a closely related western species whose range extends into central Alberta. It attacks a variety of pines. None of the tunneling done by these insects is of economic importance, except in seed orchards, where graft unions may be attacked.

Other insects that occasionally cause pitch masses on pine are the buprestids, ***Chrysobothris*** spp. None are of economic importance.

Life Cycle and Appearance

All species of *Dioryctria* occurring in the prairie provinces have one generation per year and overwinter in the larval stage. The adults have relatively narrow front wings that are variously marked with shades of gray and sometimes reddish brown. The hind wings are unmarked except for a narrow dark border along the rear edge in some species. ***Dioryctria banksiella*** adults (A) have a wingspan of 28–33 mm and are typical of the genus, except that they are slightly larger than most species. The larvae feed under the bark initially but enter the galls during the summer. They overwinter in the galls and are about 25 mm long when fully grown. They have reddish brown heads and thoracic shields and greenish gray bodies suffused with purple (C). The setae have conspicuous dark spots at their bases. Pupation occurs in late June and July, and the adults emerge about 3 weeks later.

The life cycle of ***D. abietivorella*** is similar to that of *D. banksiella*. Adults have gray front wings with inconspicuous transverse lighter bands. Hind wings are whitish gray without any markings. The larvae have reddish brown heads and thoracic shields and reddish purple bodies (B). Conspicuous dark spots occur at the base of the setae.

Dioryctria zimmermani and ***D. cambiicola*** adults are very similar. The fore wings are brownish gray and are suffused with reddish brown at the base. The hind wings of *D. zimmermani* are whitish, and those of *D. cambiicola* are dark brown. Larvae of *D. cambiicola* have reddish brown heads and thoracic shields (G). Their bodies are pink, with conspicuous reddish brown spots at the base of the setae. Larval development is completed by late June in Alberta.

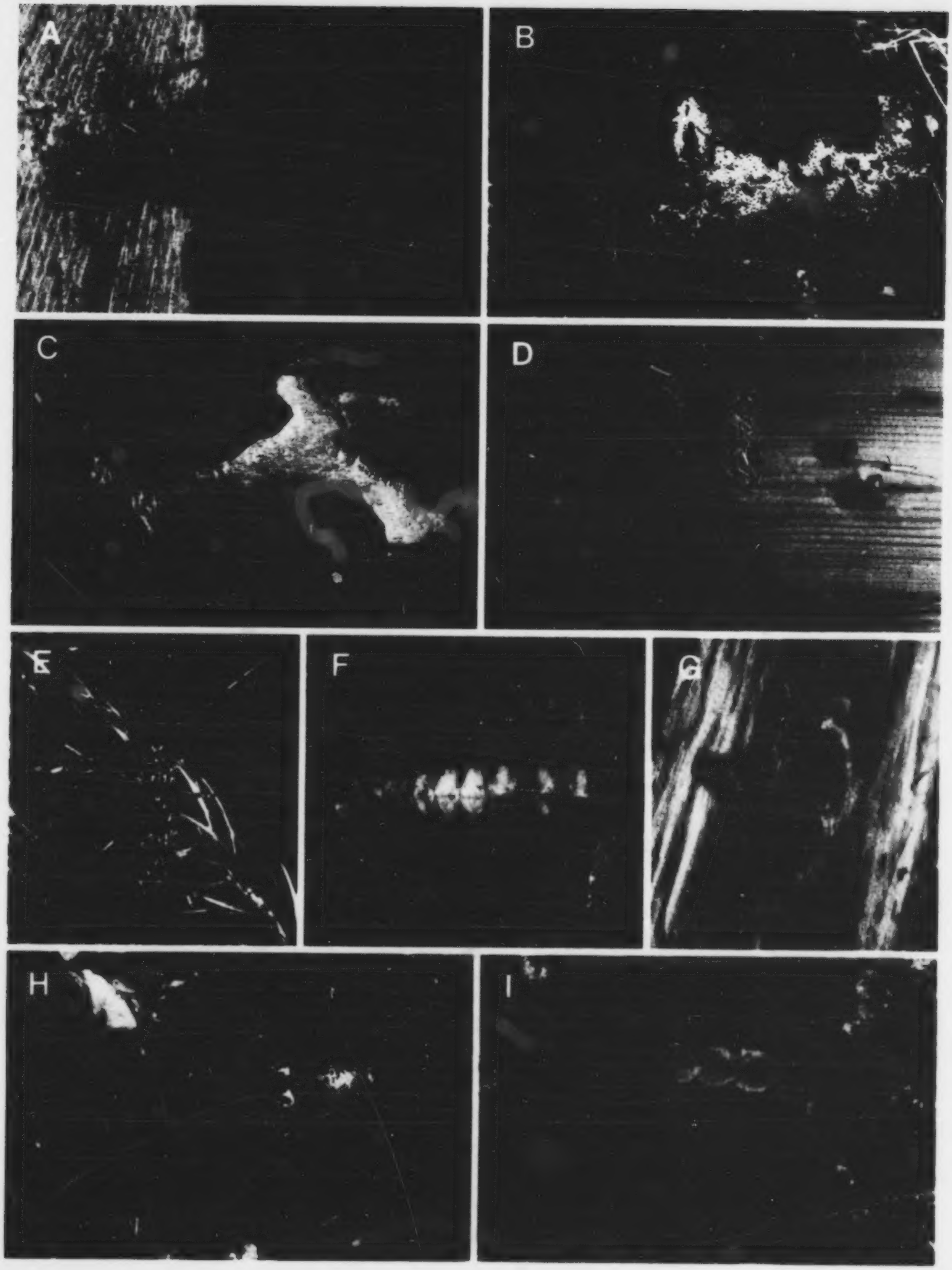
Little is known about the life histories of the various *Chrysobothris* species attacking pine in this region. Most species breed in weakened or dying trees, but some attack apparently healthy trees. The adults are moderate sized, dull colored, flattened beetles with sculptured elytra. ***Chrysobothris cribraria*** Mannerheim (H) is typical of the genus. The life cycle probably lasts 2 or 3 years. The larvae are typical flatheaded wood borers that feed in the cambial area for the 1st year (I), then enter the wood to complete their development.

Damage

The tunneling of ***D. banksiella*** in rust galls on the main stem often causes breakage of the stem at that point (E), but the effect is minimal because stem galls often kill the tree. The burrowing of ***D. abietivorella*** (D) must weaken small trees, but they eventually recover and the only external evidence of attack is the fresh pitch over the feeding site (F). The young larvae of ***Chrysobothris*** sp. cause small exudations of pitch (J), but cambial feeding is extensive, and this must have an adverse effect on small trees.

Bibliography: 85, 88, 139, 203, 345, 348, 421, 426, 427, 428, 481, 636

Figure 41. Insects associated with pitch masses. A. Adult *Dioryctria banksiella* Mutuura, Munroe and Ross. **B.** Fir coneworm, *D. abietivorella* (Grote), larva infesting main stem of young jack pine. **C.** *D. banksiella* larva. **D.** Tunnel of *D. abietivorella* larva in trunk of young jack pine. **E.** Western gall rust, *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka, infested with *D. banksiella*. **F.** Pitch mass on young jack pine caused by feeding of *D. abietivorella* larva. **G.** Mature western pine moth, *D. cambiicola* (Dyar), larva on jack pine. **H.** Adult *Chrysobothris cribraria* Mannerheim. **I.** Young *Chrysobothris* sp. larva. **J.** Pitch mass on young jack pine caused by feeding of *Chrysobothris* sp. larva.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WOOD BORERS IN CONIFERS (Figure 42)

Distribution, Hosts, and Importance

The larvae of roundheaded and flatheaded borers cause extensive damage to dead and dying coniferous trees and logs. One of the most important of the roundheaded borers attacking conifers throughout the prairie provinces is the whitespotted sawyer, ***Monochamus scutellatus*** (Say). It attacks spruce, pine, true firs, Douglas-fir, and occasionally tamarack. The northeastern sawyer, ***M. notatus*** (Drury), is an eastern species whose range extends as far west as Alberta. It attacks white pine, balsam fir, and spruce. Two other common and widely distributed roundheaded borers are the northern spruce borer, ***Tetropium cinnamopterum parvulum*** Casey, on white and Engelmann spruces and the eastern larch borer, ***T. cinnamopterum*** Kirby, on white spruce, balsam fir, and jack pine.

Flatheaded borers are usually of less importance than roundheaded borers, because they do not penetrate the wood as deeply. Only ***Buprestis intricata*** Casey, which attacks lodgepole pine, is discussed.

Life Cycle and Appearance

Monochamus scutellatus usually requires 2 years to complete its life cycle in the prairie provinces. Adults (A) emerge from early June to late July, depending upon location and weather. They have lateral spines on the thorax, bodies measuring 20–25 mm long, and are black or mottled gray except for a white spot at the base of the elytra. Males have antennae about twice as long as their bodies, and females have antennae about the same length as their bodies. The adults feed on coniferous foliage and bark for about 10 days before mating, which usually occurs on a warm, sunny day. The females chew slits in the bark, usually in a crease or near a branch, and deposit one or more white, elongate eggs per slit. They lay most of their eggs on the shaded or lower surface of the logs but tend to avoid deep shade. The eggs hatch in about 2 weeks, and the legless larvae begin feeding in the cambial area. The larvae feed in the phloem for several weeks, scoring the surface of the wood, before excavating an oval hole to enter the sapwood (C), where they overwinter. Chips and frass are expelled through holes in the bark and often accumulate at the base of standing trees (B). Feeding is resumed the following spring, and the larvae frequently penetrate deep into the heartwood (D) before working their way back towards the surface. Usually they do this by excavating U-shaped oval tunnels, but they may bore straight through smaller logs. Fully grown larvae are 35–50 mm long and have dirty-white bodies, yellowish thoraxes, and brown heads. Pupal cells are formed near the surface of the logs, but pupation does not occur until the following spring. The adults cut circular emergence holes. ***Monochamus notatus*** has a similar life cycle, but the adults are larger (bodies 25–35 mm long) and are mottled gray, white, and black in color (E).

Tetropium cinnamopterum parvulum and ***T. cinnamopterum*** both complete their life cycles in 1 year. Separation of the species is best left to a specialist. The adults of both species are brownish black and range in length from 8 to 12 mm (exclusive of antennae). They emerge from infested logs between May and July, but mostly in June. Male antennae are about one-half the length of their bodies. Females lay their eggs under bark scales, and the young larvae feed in the cambial area before entering the sapwood (G), where they excavate L-shaped galleries that usually penetrate the wood to a depth of 25–35 mm. The larvae are dirty-white, legless grubs with brown heads (F). Pupal chambers are constructed at the distal ends of the larval galleries.

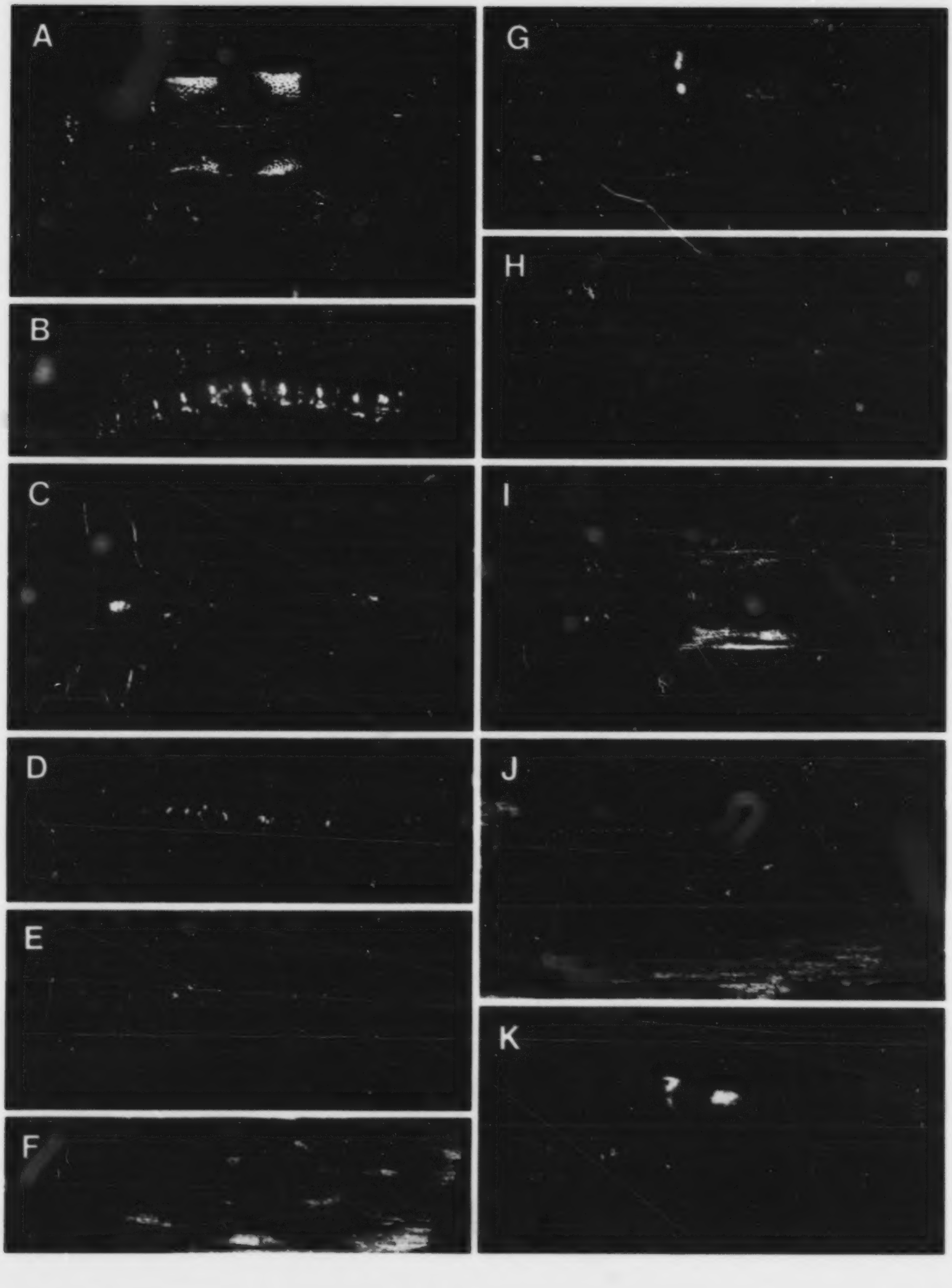
Many buprestid adults have a metallic sheen, the color of which depends upon the species. They are heavily chitinized, flattened beetles ranging in length from 10 to 25 mm. ***Buprestis intricata*** is typical (H). Buprestid larvae typically have small heads, slender segmented bodies, and a wide flattened thorax (I) that has horny dorsal and ventral plates. The larvae make frass-filled flattened tunnels in the bark, phloem, or sapwood, but a few species penetrate into the heartwood. Completion of the life cycle usually requires 2–3 years but may take longer in dry wood.

Damage

Borers are of economic importance primarily because they are among factors shortening the length of time that logs can be salvaged following fires or other disasters. They can also become a major problem if freshly cut log decks are left in the woods during the summer months. In untended, natural forests they are beneficial insects, because they accelerate the breakdown of the wood in dead trees. ***Monochamus scutellatus*** adults occasionally cause serious defoliation of trees around large clear-cut areas.

Bibliography: 93, 139, 203, 368, 461, 462, 482, 609, 626

Figure 42. Wood borers in conifers. A. Adult whitespotted sawyer, *Monochamus scutellatus* (Say). **B.** Wood chips and frass at base of dead white spruce tree infested with *M. scutellatus*. **C.** Excavations in surface of sapwood made by a young *M. scutellatus* larva. Note oval entrance hole near top of excavation. **D.** *M. scutellatus* galleries and larvae in white spruce log. **E.** Adult northeastern sawyer, *M. notatus* (Drury). **F.** Northern spruce borer, *Tetropium cinnamopterum parvulum* Casey, larva. **G.** Excavations in surface of sapwood made by a young *T. cinnamopterum parvulum* larva. Note entrance hole near top of excavation. **H.** Adult *Buprestis intricata* Casey. **I.** Typical buprestid larva on white spruce.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MINOR WOOD BORERS IN CONIFERS (Figure 43)

Distribution, Hosts, and Importance

Numerous species of minor wood borers infest dead conifers in this region, but none are of economic importance. The cedar tree borer, ***Semanotus ligneus ligneus*** (Fabricius), attacks most conifers, but the preferred host is eastern white cedar. The firtree borer, ***S. litigiosus*** (Casey), attacks Douglas-fir, white spruce, Englemann spruce, alpine fir, and probably balsam fir. It is a western species that has been reported from southwestern Alberta. The blazedtree borer, ***Serropalpus substriatus*** Haldemann, attacks various conifers and was found in recently killed balsam fir in southeastern Manitoba.

The black fire beetle, ***Melanophila acuminata*** DeGeer, attacks balsam fir, white spruce, pine, and eastern white cedar. It is one of several members of the genus that are attracted to forest fires, often over considerable distances. The flatheaded fir borer, ***M. drummondi*** (Kirby), attacks Douglas-fir, true firs, and spruces. Both species occur throughout the region. ***Pygoleptura nigrella*** (Say) and ***Judolia montivagens*** (Couper) (= *Anoplodera sexmaculata* (Linnaeus)) are examples of borers attacking decaying spruce and pine throughout the region.

Life Cycle and Appearance

The insects discussed herein probably require 2 years to complete their development in the prairie provinces. All but the two *Semanotus* species are believed to overwinter twice in the larval stage.

Semanotus ligneus ligneus adults (A) emerge from hibernation in May. They are black, except for the yellow or orange on the elytra, and range in length from 8 to 15 mm. Females lay their eggs in slits cut into the bark. The larvae (B) are creamy-white with brown heads and reach a length of about 25 mm when mature. Young larvae excavate meandering tunnels in the cambial area for the first summer and overwinter in these tunnels. Similar feeding continues throughout the second summer. Mature larvae tunnel into the sapwood in early fall and construct pupal cells just below the surface. Adults develop in the fall but remain in the pupal cells until the following spring. ***Semanotus litigiosus*** adults (not shown) are 9-16 mm long and resemble dark, hairy *S. ligneus ligneus* adults, with the orange on the elytra mostly or entirely missing. The life cycle is probably similar to that of *S. ligneus ligneus*.

Serropalpus substriatus adults (C) have relatively long antennae and are 12-20 mm long. Most specimens are light purplish brown upon emergence but darken with age. The legless larvae (D) have light brown heads and creamy-white bodies. The abdominal segments are very prominent, and there is a pair of small chitinized horns at the rear of the abdomen. Mature larvae are 15-25 mm long. Feeding is confined to the sapwood, and the larvae bore circular tunnels, packing the fine frass behind them (F). Pupal cells (E) are excavated just below the surface.

Melanophila acuminata adults (G) are black with pointed elytra and are 7-13 mm long. The larvae (H) are legless and reach a length of 25-30 mm. They have brown heads and white or creamy-white bodies, and the thoraxes are broad and flattened. Young larvae tunnel in the cambial area, but older larvae bore into the outer layers of wood. ***Melanophila drummondi*** adults (not shown) are similar to those of *M. acuminata* but are bronze-black in color with six small yellow spots on the elytra. The larvae tunnel in the inner bark, scoring the sapwood.

Pygoleptura nigrella adults (I) are attracted to flowers, are 13-19 mm long, and are black or black with brownish elytra. The latter resemble *Trigonarthris proxima* (Say) (Fig. 113). The larvae (J) have light brown heads and cream-colored bodies and are about 25 mm long at maturity. They have rudimentary thoracic legs and conspicuous abdominal segments that each bear numerous small dorsal and ventral papillae. The larvae burrow in decaying wood that is not yet punky. ***Judolia montivagens*** adults (K) are also attracted to flowers. They are black with black-spotted yellowish elytra and are 8-11 mm long.

Damage

The amount of damage caused by these wood borers is usually of little concern, as the tunneling is confined to the outer layers of wood or occurs in wood that is useful only as firewood. The two flatheaded wood borers, ***M. acuminata*** and ***M. drummondi***, may occasionally cause economic damage. The first occasionally becomes locally abundant following fires and may reduce the length of the salvage period. The second is capable of killing living trees that are growing under stress brought on by drought or defoliating insects.

Bibliography: 34, 35, 97, 139, 171, 172, 173, 174, 203, 207, 244, 245, 340, 361, 475, 568, 613, 614

Figure 43. Minor wood borers in conifers. **A.** Adult cedar tree borer, ***Semanotus ligneus ligneus*** (Fabricius). **B.** ***S. ligneus ligneus*** larva. **C.** Adult blazedtree borer, ***Serropalpus substriatus*** Haldemann. **D.** ***S. substriatus*** larva. **E.** ***S. substriatus*** pupa. **F.** Frass-filled ***S. substriatus*** galleries. **G.** Black fire beetle, ***Melanophila acuminata*** DeGeer. **H.** ***Melanophila*** sp. larva.* **I.** Adult ***Pygoleptura nigrella*** (Say). **J.** ***P. nigrella*** larva. **K.** Adult ***Judolia montivagens*** (Couper) (= ***Anoplodera sexmaculata*** (Linnaeus)).

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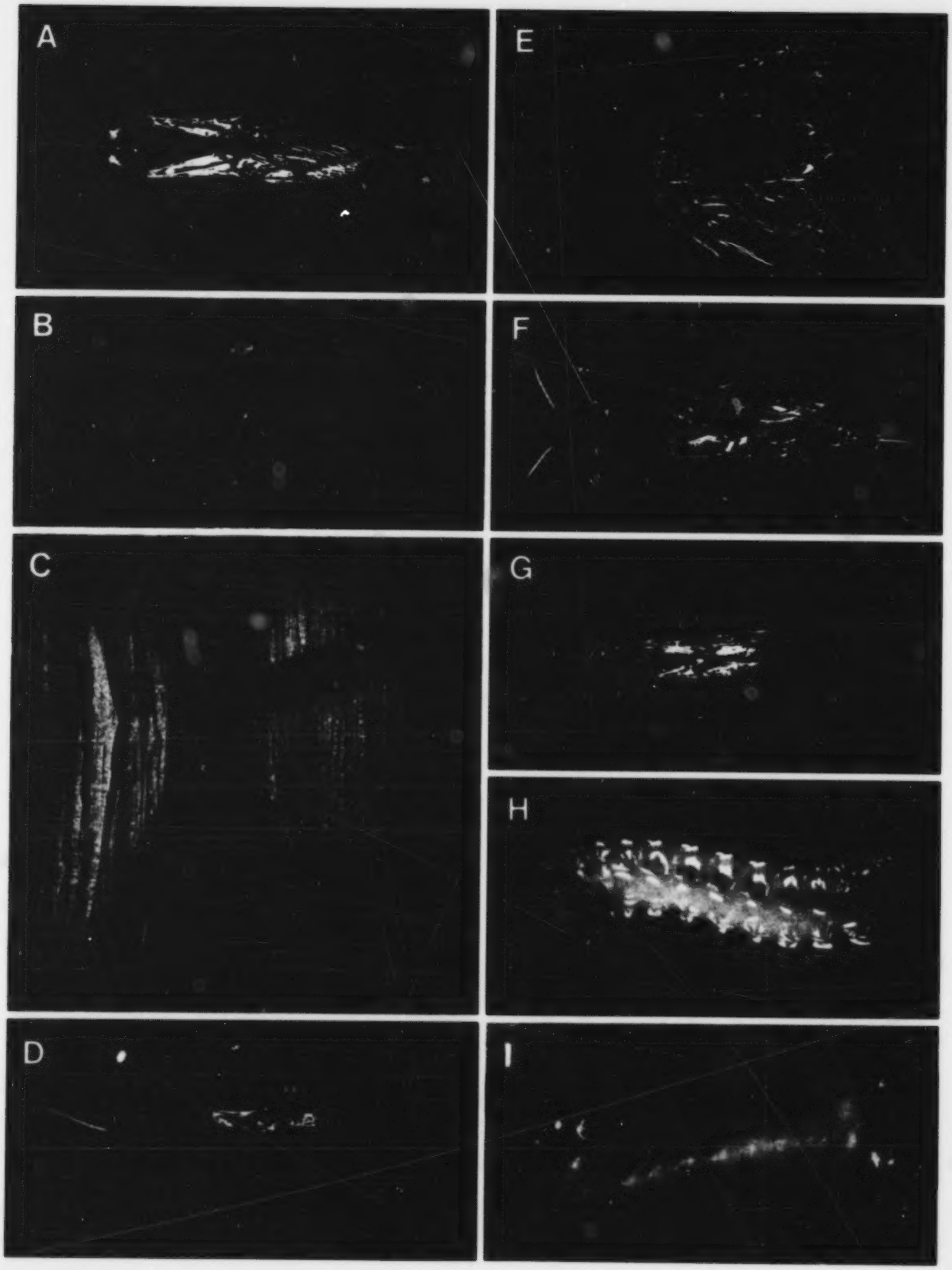
* Photograph courtesy of Pacific Forestry Centre.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HORNTAILS ATTACKING CONIFERS (Figure 44)

Distribution, Hosts, and Importance

Horntails are a group of wasplike insects that attack weakened, dying, or recently dead trees. The blue horntail, ***Sirex cyaneus*** Fabricius, attacks balsam fir, spruce, pine, and larch. The banded horntail, ***Urocerus gigas flavicornis*** (Fabricius), burrows in a variety of softwoods, particularly spruce. The black and red horntail, ***U. cressoni*** Norton, ranges west to Manitoba and attacks balsam fir, spruce, and pine. The black horntail, ***U. albicornis*** (Fabricius), attacks most species of conifers. ***Xeris spectrum spectrum*** (Linnaeus) burrows in balsam fir, spruce, pine, and larch. Unless otherwise noted, all species occur throughout the region.

These insects are of no economic importance, because they do not kill trees. The females of most species, however, often carry spores of rot-causing fungi in special organs, and large horntail populations may significantly reduce the length of the salvage period for fire- or insect-killed timber.

Life Cycle and Appearance

The life cycles of most North American horntails are not fully understood, and some of the taxonomic relationships require further study.

Sirex cyaneus usually requires 2 years to complete its life cycle, but some individuals may require 3 years. The adults (A) emerge during the summer or early fall, and the males tend to emerge before the females. Most females are about 25 mm long, excluding the ovipositor, and the males are somewhat smaller. Both have a hornlike projection at the rear of the abdomen. The females have bluish black abdomens, black antennae, and reddish brown legs. The males have varying amounts of orange on the abdomen, and the hind legs are mostly bluish black. The female uses her ovipositor to puncture the sapwood to a depth of 2–10 mm. One to three eggs are deposited in each puncture. Some of the eggs hatch almost immediately, but most overwinter. The larvae initially feed at right angles to the oviposition puncture, and they then turn and tunnel deeper into the log. The larval galleries are up to 20 cm long, are tightly parked with fine frass (C), and seldom penetrate deeper than 4 cm. All horntail larvae (H, I) are similar in appearance. They have yellowish heads and creamy-white bodies that have a characteristic shallow S-shape. The thoracic legs are vestigial, and the rear of the abdomen bears a chitinous dorsal horn that is used to propel the larva forward. There are 5–11 larval instars. Pupal cells are formed near the surface of the wood, and the adults chew a circular emergence hole through the bark (B).

The life cycles of the four remaining horntail species are probably similar to that of *S. cyaneus*, and all have caudal horns. Only the appearance of female adults will be discussed for each of these. *Urocerus* and *Xeris* have a pale spot behind each eye, which serves to separate them from *Sirex*. *Urocerus* species have oval eyes and a relatively short ovipositor; *Xeris* species have round eyes and a long ovipositor.

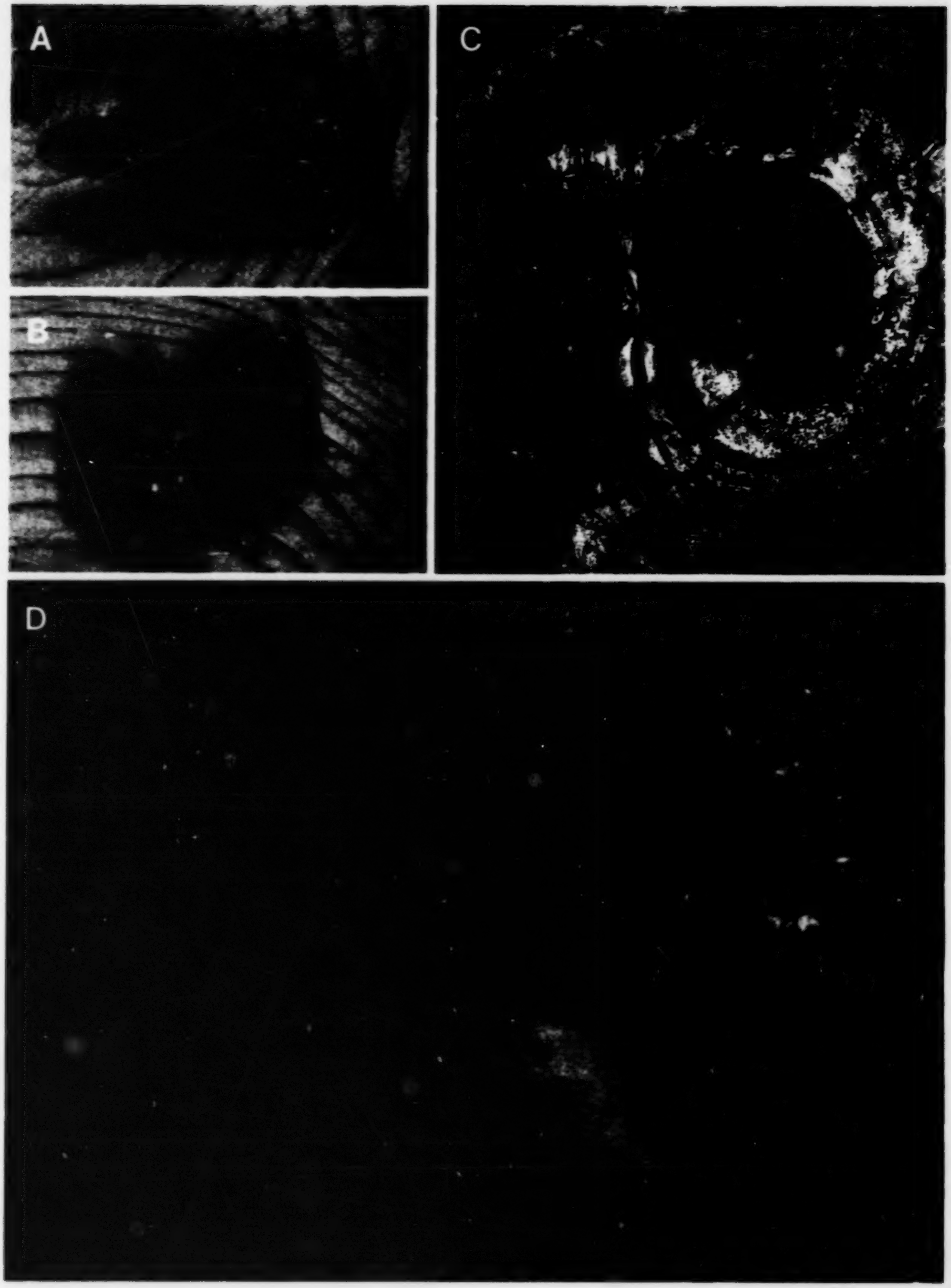
Urocerus gigas flavicornis females (D) have black heads, thoraxes, and abdomens. The antennae, the spots behind the eyes, the seventh and eighth abdominal segments, and sometimes the second abdominal segment are all yellow. ***Urocerus cressoni*** females (E) have black heads and thoraxes and variable amounts of red on the abdomen that fade to brown in pinned specimens. The apical segments of the antennae, the large spot behind the eyes, and the portions of the segments on the hind legs are pale. ***Urocerus albicornis*** females (F) have black heads, thoraxes, and abdomens. Most of the antennae, the large spot behind each eye, and the basal portions of the leg segments are all white. ***Xeris spectrum spectrum*** females (G) have black heads, thoraxes, and abdomens. The small spot behind each eye is white, the antennae are black, and the legs are reddish.

Damage

The tunneling of horntail larvae reduces the quality of timber cut from infested logs, but the volume loss is minimal because the tunnels are near the surface. The increased rate of decay attributable to rot organisms disseminated by the females is the major damage caused by horntail attack.

Bibliography: 39, 87, 99, 139, 203, 237, 403, 417, 558

Figure 44. Horntails attacking conifers. A. Blue horntail, *Sirex cyaneus* Fabricius. **B.** *S. cyaneus* adult emergence hole. **C.** *S. cyaneus* larval gallery, showing tightly packed frass and pupal chamber at upper right. **D.** Banded horntail, *Urocerus gigas flavicornis* (Fabricius). **E.** Black and red horntail, *U. cressoni* Norton. **F.** Black horntail, *U. albicornis* (Fabricius). **G.** Adult *Xeris spectrum spectrum* (Linnaeus). **H.** Side view of *X. spectrum spectrum* larva. **I.** *X. spectrum spectrum* larva in gallery.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CARPENTER ANTS (Figure 45)

Distribution, Hosts, and Importance

Ants belonging to the genus *Camponotus* are known as carpenter ants because they excavate their nests in wood. There has been considerable disagreement among taxonomists concerning the validity of several species within the genus. The limited information available indicates that the red and black carpenter ant, ***C. herculeanus*** (Linnaeus), is the most common species in the forested areas of the prairie provinces. Their nests may be formed in stumps, fallen logs, or standing trees. The latter are attacked only if there are scars or cracks through which the ants can gain entry. White spruce, lodgepole pine, balsam fir, and eastern white cedar are the principal hosts in this region. The red carpenter ant, ***C. noveboracensis*** (Fitch), is probably more common in the aspen parkland area of the three provinces. The black carpenter ant, ***C. pennsylvanicus*** (DeGeer), is an eastern species whose range extends into southern Manitoba. None of these carpenter ants are serious pests in most forest situations but may be abundant if the trees are growing under marginal conditions where scars are likely to occur because of grass fires or mechanical injury.

Life Cycle and Appearance

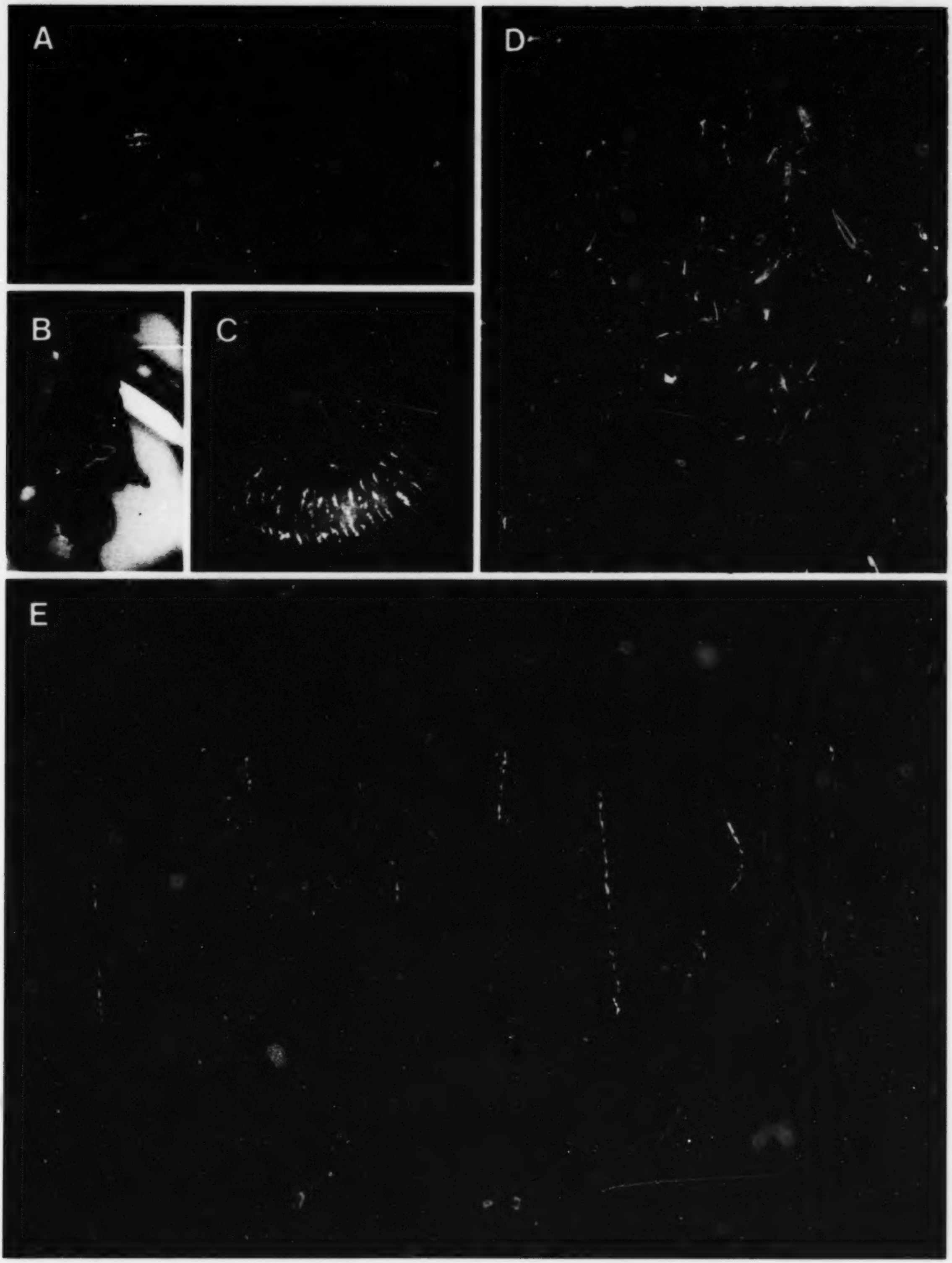
Carpenter ants are social insects. They do not eat wood but simply excavate it to form their nests. Their food consists of aphid honeydew, fungus, and dead insects. The life histories of the three most common species in the prairie provinces are probably similar. Only that of ***C. herculeanus*** will be discussed. The life cycle probably requires 2 years to complete in this region. Overwintering, fully established colonies contain a queen, workers, young winged male and female adults, and two sizes of larvae. All the adults are dark colored. The young females (A) are 15–20 mm long. The males are about 10 mm in length, and workers range in length from 6 to 10 mm. The winged adults emerge from the nest early in the spring and swarm on calm, warm days. They mate while in flight. The young queen then sheds her wings (B) and seeks a suitable location in which to start a new colony. She rears a small brood of 10–20 workers, feeding them from food reserves in her body. Subsequent enlargement and maintenance of the colony is carried out by the workers, two-thirds of which are much smaller than the rest. The queen probably lays eggs throughout the summer, although larval development occurs primarily during June and early July. Cocoons containing pupae occur from late June to late August, and the adults emerge several weeks later. The winged forms remain with the colony until the following spring. Colonies may be active for as long as 15 years, but this is dependent upon survival of the original queen. If she dies or exhausts her supply of sperm the colony will die out.

Damage

Some authorities have considered carpenter ants to be a major pest of timbers and log buildings in areas with a more humid climate than is normally found in the prairie provinces. Other experts disagree, pointing out that the ants attack only wood that is in the process of decaying. The ants merely hasten the process. In this region, carpenter ants may infest some power poles, especially if they contain heart rot, but most nests are probably constructed in stumps, fallen logs, and standing trees, where their activities are largely beneficial, because they hasten the breakdown of forest residues. Some damage is caused if the nests are constructed in living trees (D), because the removal of wood leaves a bole that is essentially hollow (C). This may weaken the tree, thus contributing to breakage during windstorms. Little sound wood is destroyed by the ants, however, even though the nests may extend into the bole for 1 m or more, because most of the nests are excavated in decayed wood.

Bibliography: 113, 491, 494, 495, 508, 525, 610

Figure 45. The red and black carpenter ant, *Camponotus herculeanus* (Linnaeus). **A.** Winged female *C. herculeanus.* **B.** Wingless female *C. herculeanus.* **C.** Cross section of white spruce showing carpenter ant excavations. **D.** Living spruce tree containing carpenter ant nest. Note pile of wood chips at base of tree.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THE STRAWBERRY ROOT WEEVIL AND THE BLACK VINE WEEVIL (Figure 46)

Distribution, Hosts, and Importance

The strawberry root weevil, ***Otiorhynchus ovatus*** (Linnaeus), and the black vine weevil, ***O. sulcatus*** (Fabricius), are among several members of the genus that were accidentally introduced into North America many years ago. ***Otiorhynchus ovatus*** occurs throughout the agricultural areas of the prairie provinces and is occasionally a serious pest in forest nurseries. The adults feed on the foliage of a wide variety of plants including juniper, white cedar, spruce, and pine. Larvae have caused damage in plantings of spruce and dogwood. ***Otiorhynchus sulcatus*** probably occurs in much the same area as *O. ovatus*, but its distribution is spotty. It is primarily a pest of broad-leaved evergreens but also attacks juniper, white cedar, maple, and hawthorn.

Only ***O. ovatus*** is currently of any economic importance in the region, especially if alfalfa or clover are grown in close proximity to nursery beds or have been used in rotation to improve soil quality. ***Otiorhynchus sulcatus*** has been collected in Manitoba and Saskatchewan and is therefore a potential pest in the prairie provinces.

Life Cycle and Appearance

Otiorhynchus ovatus has one generation per year in the prairie provinces, overwintering primarily as larvae in the soil. Adults (A) are all females and may also survive the winter in sheltered locations. They are 5–6 mm long, parthenogenetic, and wingless, with fused elytra that have inconspicuous yellow setae. The antennae are long, and the body is oval, shiny, and dark brown or black. The front femur has a notched or bilobed tooth (B). The legless larvae (C) have brown heads and C-shaped whitish bodies. They are about 8 mm long at maturity. The larvae pupate in the spring, and the adults emerge in late spring or early summer. They feed on the foliage and tender bark of their hosts and lay their eggs in the soil near plants. The larvae feed on the roots, severing the small roots and girdling larger ones.

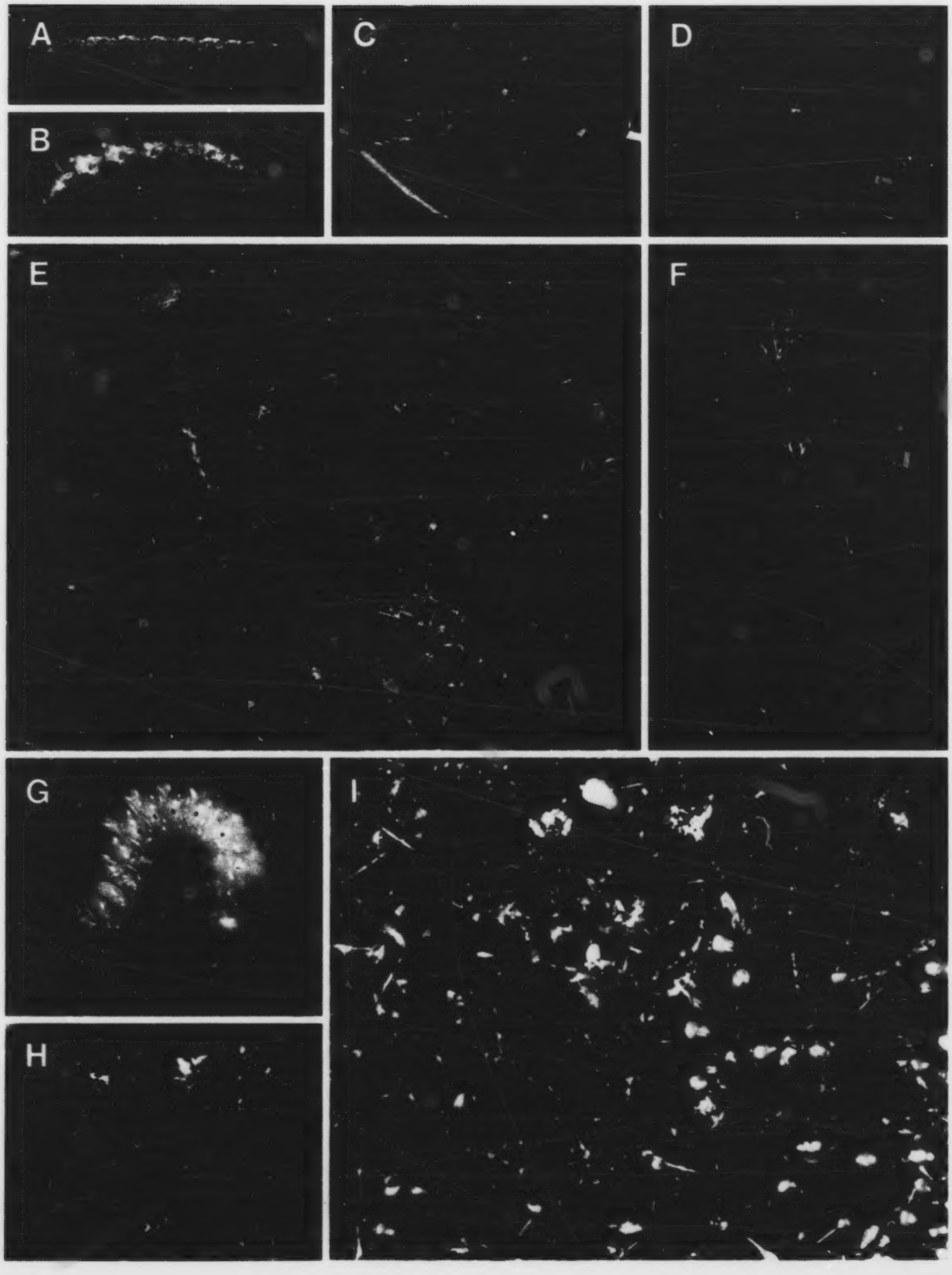
The life history of ***O. sulcatus*** is similar to that of *O. ovatus*. The adults (not shown) are black or brownish black, with curved yellow hairs on the rough prothorax, and are 8–12 mm long. There are patches of curved, yellow hairs on the elytra, and the spur on the front femur is not notched or bilobed. The larvae are also similar to those of ***O. ovatus*** but are larger at maturity.

Damage

Heavy infestations of ***O. ovatus*** adults may cause serious injury to the foliage of young white cedar and other conifers. Larval feeding has killed dogwood (D) and white spruce (E) seedlings in the prairie provinces. ***Otiorhynchus sulcatus*** adults seldom cause serious damage, but the larval feeding may weaken nursery stock so that the seedlings die after transplanting. No such damage has been reported in this region.

Bibliography: 139, 206, 297, 477, 595

Figure 46. The strawberry root weevil, *Otiorhynchus ovatus* (Linnaeus). A. Adult *O. ovatus*. **B.** Front femur of *O. ovatus* adult showing notched or bilobed tooth. **C.** *O. ovatus* larva. **D.** Dogwood seedlings killed by *O. ovatus* larval feeding. **E.** White spruce seedlings killed by *O. ovatus* larval feeding.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ADDITIONAL INSECTS ATTACKING TREE SEEDLINGS (Figure 47)

Distribution, Hosts, and Importance

Several species of unrelated insects are occasionally abundant in forest nurseries or plantations. The insects involved probably occur throughout the region, but their damage has been reported only from widely separated locations.

The celery stalkworm, ***Nomophila nearctica*** Munroe, has destroyed containerized spruce seedlings in Saskatchewan and Manitoba. ***Ochropleura plecta*** (Linnaeus) is one of several species of cutworms that have attacked spruce and lodgepole pine seedlings in Alberta. Crane fly larvae, ***Tipula*** sp., have damaged containerized spruce seedlings in Manitoba and Alberta.

White grub larvae, ***Phyllophaga*** sp., are occasionally a major problem in red pine and jack pine plantations in southeastern Manitoba. Pill beetle larvae, ***Byrrhus*** sp., have reportedly damaged tree seedlings in forest nurseries. Another pill beetle, ***Tylicus subcanus*** LeConte, was very abundant in Saskatchewan, but investigation showed that this species feeds on moss, not seedlings. An adelgid, ***Pineus coloradensis*** (Gillette), has damaged lodgepole pine seedlings in Alberta (Fig. 4).

Life Cycle and Appearance

The life cycle of ***N. nearctica*** has not been studied in the prairie provinces, but it is believed to overwinter in the pupal stage and may have two generations per year. The moths are gray with bronze markings and have a wingspan of about 30 mm. Mature larvae (A, B) are 20-25 mm long. The head and thoracic shield are black, and the body is whitish below and purplish gray above. There are two rows of conspicuous black spots along the back. The larvae sever the seedlings (E) and drag them into burrows to feed. ***Ochropleura plecta*** probably has two generations per year and hibernates in the pupal stage. Adults have reddish brown front wings with grayish shoulders, whitish hind wings, and a wingspan of 25-30 mm. The larvae (C) are reddish brown and have broken white middorsal and subdorsal lines.

Tipula sp. adults (D) resemble oversized mosquitoes and have a wingspan of about 25 mm. The larvae develop in moist locations and are very general feeders, sometimes eating the bark on the roots of small seedlings (F).

Phyllophaga sp. larvae may require 3 or 4 years to complete development. The larvae overwinter below the frost line and do most of their feeding in the late instars, when small roots may be severed and larger roots girdled. The larvae (G) are creamy-white and have brown heads and well-developed legs. They reach a length of about 40 mm when fully grown. The C-shaped position of the larva is typical. The adults are stout-bodied brown or black beetles. They emerge during the summer and feed on the foliage of various hardwoods during warm nights (Fig. 55).

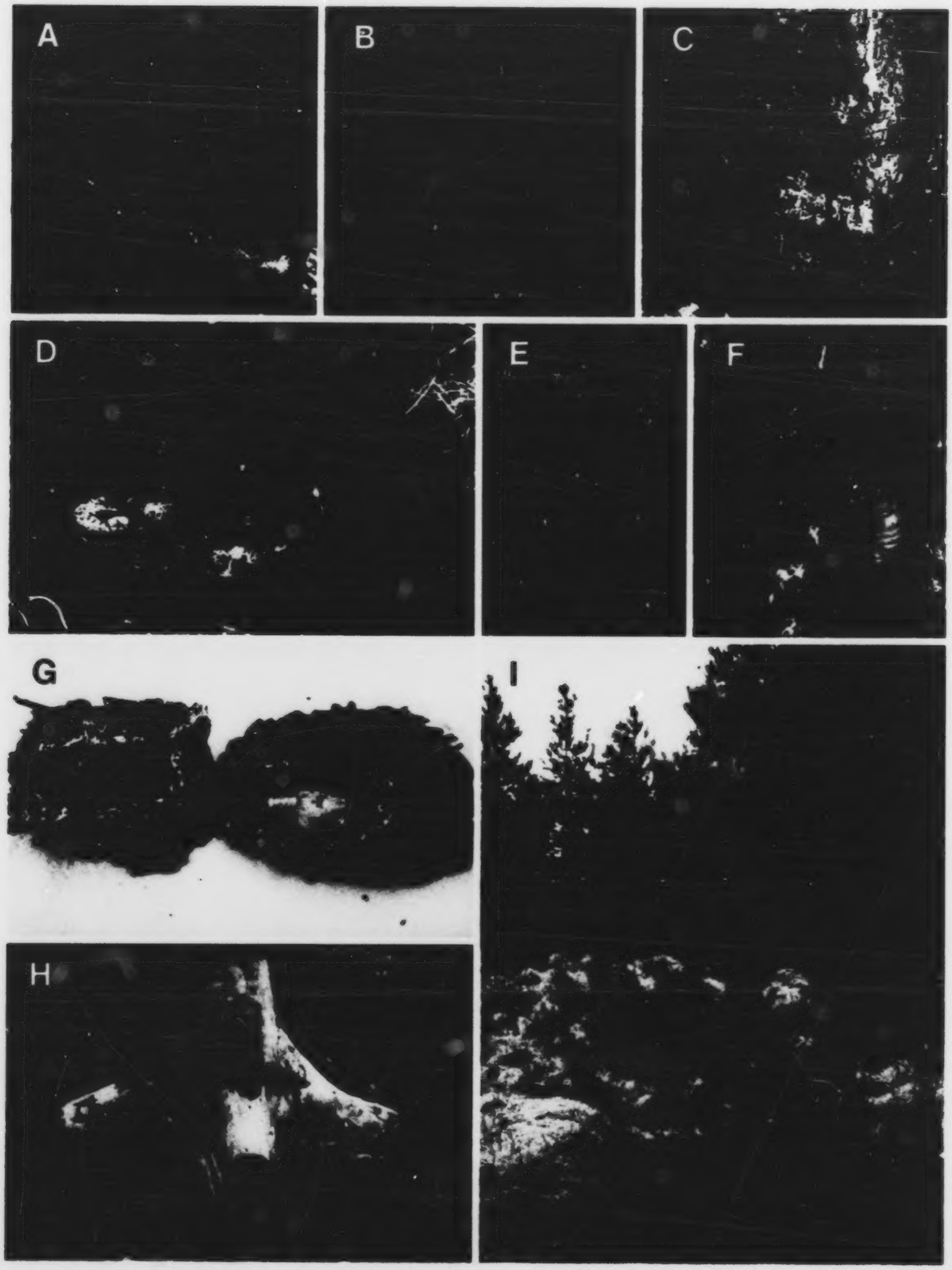
Little is known about the life cycle of ***T. subcanus***, but the insect apparently has one generation per year and overwinters in the adult stage. The beetles are black, rounded, and are 4-5 mm long. Mature larvae (H, I) are black and are about 7-9 mm long at maturity. The life history of ***P. coloradensis*** is discussed elsewhere (Fig. 4).

Damage

Pineus coloradensis sucks the sap from the seedlings, causing the foliage to turn yellowish, but the seedlings are not usually killed. ***Nomophila nearctica*** and the various cutworms, including ***O. plecta***, sever the seedlings (E). ***Tipula*** sp. larvae and the various ***Phyllophaga*** species sever or girdle the roots of the seedlings (F), weakening or killing them. ***Tylicus subcanus*** does not injure the seedlings, but some workers find the abundant larvae (I) to be objectionable.

Bibliography: 139, 188, 191, 203, 296, 356, 423, 564, 641

Figure 47. Additional insects attacking tree seedlings. A. Dorsal view of celery stalkworm, *Nomophila nearctica* Munroe, larva. **B.** Lateral view of *N. nearctica* larva. **C.** *Ochropleura plecta* (Linnaeus) larva. **D.** Adult crane fly, *Tipula* sp. **E.** Spruce seedlings severed by *N. nearctica* larva. **F.** Spruce seedling girdled by *Tipula* sp. larval feeding. **G.** *Phyllophaga* sp. larva. **H.** *Tylicus subcanus* LeConte larva. **I.** *T. subcanus* larvae feeding on moss.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ROOT COLLAR WEEVILS AND THEIR ALLIES (Figure 48)

Distribution, Hosts, and Importance

Only three of the five species of *Hylobius* occurring in the prairie provinces attack the roots and root collars of various conifers. The Warren rootcollar weevil, ***H. warreni*** Wood, feeds on white spruce, jack pine, lodgepole pine, and several other coniferous species throughout the area. Rates of infestation vary but are usually greatest on moist or wet sites. The Couper collar weevil, ***H. pinicola*** (Couper), attacks primarily white spruce and tamarack on moist or wet sites. Although less important than *H. warreni*, it is relatively common throughout the area. The pine rootcollar weevil, ***H. radicis*** Buchanan, is an eastern species whose range extends into southeastern Manitoba. It attacks Scots pine, eastern white pine, and jack pine.

The larvae of two other species of *Hylobius* that occur in the prairie provinces feed on the inner bark of various coniferous logs or stumps. ***Hylobius congener*** Dalla Torre, Schenkling and Marshall attacks red pine, white pine, and Scots pine. Adults feed on the inner bark of logs and slash. Pales weevil, ***H. pales*** (Herbst), has a wide range of coniferous hosts. Adults feed on the tender bark of twigs and seedlings. Neither species is of any economic importance in the prairie provinces.

Life Cycle and Appearance

Hylobius warreni has a 2-year life cycle, and the adults live and lay eggs for as long as 4 years. They are stout-bodied weevils, 12–15 mm in length. The basic body color is dark brown or black; it is covered with white or pale yellow hairs or scales that form irregular spots on the elytra and give the body a grayish appearance (A). The adults have rudimentary hind wings and cannot fly. They feed on the host needles or on the bark of twigs and small roots. The larvae are whitish, legless grubs with brown heads (B). They feed in the bark and cambial area of the host tree at or below the duff surface, causing copious flows of resin (C). Roots or basal stems over 25 mm in diameter are tunneled by the larvae (D). These tunnels often girdle small trees. Last-instar larvae (up to 20 mm in length) form cells near the base of the tree (D, G) in which to pupate. The exarate pupae are creamy-white in color and are about the same size as the adults. ***Hylobius pinicola*** is very similar in appearance and habits to *H. warreni* and often feeds on the same hosts, but the adults have fully developed hind wings. ***Hylobius radicis*** adults (E) are slightly smaller (10–12 mm in length) than the two preceding species. Their bodies are a dull reddish brown covered with yellow setae that are concentrated into spots on the elytra. The insect probably has a 1-year life cycle and overwinters in various stages. Its larvae (F), habits, and damage otherwise resemble those of the other two species of collar weevils.

Hylobius congener and ***H. pales*** probably both have 1-year life cycles, but very little is known about them in the prairie provinces. Adults of both species have been collected at widely scattered locations throughout the region. *Hylobius congener* adults are 6–8 mm long. They are dark reddish brown to black in color and are covered with whitish setae that form an irregular pattern on the elytra. *Hylobius pales* adults are somewhat larger, ranging in length from 6 to 11 mm. They are also dark reddish brown to black in color and are covered with inconspicuous brownish setae.

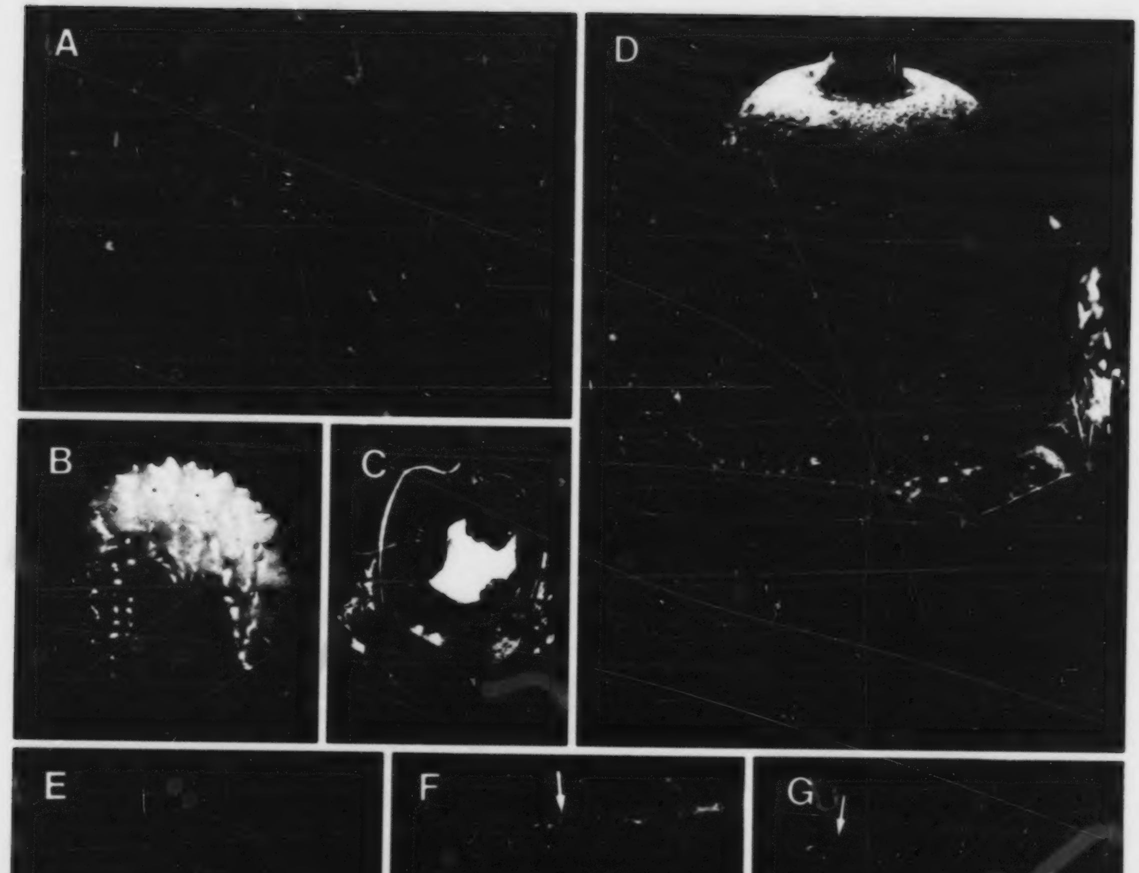
Damage

Hylobius warreni feeding sometimes kills young trees and is one of the most significant entry courts for root rot and other disease organisms on older trees. Young trees that die during the winter have a bleached appearance in early spring (I), while the foliage on those dying at other times of the year usually turns a reddish brown. Repeated attacks on mature trees (H), in addition to providing entrance courts for disease, cause a small but significant loss in height and radial increment. ***Hylobius pinicola*** and ***H. radicis*** cause similar damage.

Bibliography: 91, 139, 203, 366, 594, 596, 597, 611, 654

Figure 48. Root collar weevils. A. Adult Warren rootcollar weevil, *Hylobius warreni* Wood. **B.** *H. warreni* larva. **C.** Early evidence of *H. warreni* damage. **D.** *H. warreni* damage and larva in pupal cell. **E.** Adult pine rootcollar weevil, *H. radicis* Buchanan. **F.** *H. radicis* larva. **G.** *H. warreni* adult and pupa in pupal cells. **H.** *H. warreni* damage on 65- to 70-year-old lodgepole pine. **I.** Young lodgepole pine tree killed by *H. warreni.*

INSECTS ATTACKING HARDWOODS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SEED INSECTS OF HARDWOODS (Figure 49)

Distribution, Hosts, and Importance

Very little is known about the insects attacking the seeds of hardwood trees and shrubs in the prairie provinces. ***Curculio iowensis*** (Casey) attacks bur oak acorns in Manitoba, and ***Proteoteras* nr. *aesculana*** Riley burrows into the seeds of Manitoba maple throughout the region. A close relative of the latter species bores into the shoots (Fig. 107), but further studies are required to clarify the taxonomic relationships. Neither of the seed-infesting species is of economic importance.

The weevils ***Thysanocnemis bischoffi*** Blatchley and ***T. helvola*** LeConte probably infest the seeds in natural ash stands in the region, but this has not been confirmed. They are of no economic importance in areas where they are known to occur.

Life Cycle and Appearance

The life cycles have not been determined for any of these insects in the region. ***Curculio iowensis*** adults (A) are present during the summer and lay their eggs in the developing acorns. The adults are stout-bodied weevils with long snouts and are 8–10 mm long. The legs and body are heavily clothed with hairs; those on the elytra form a mottled light and dark gray pattern. The larvae (B) are about 8 mm long when mature. They have brown heads and creamy-white, C-shaped bodies. The larvae emerge from the ripe acorns (C, D) and drop to the soil, where pupation apparently occurs more than 1 year later.

Adult ***P.* nr. *aesculana*** (E) have wingspans of about 12 mm. The front wings are mottled brown or gray, and the hind wings are pale. The moths are active from mid-May to late June. The transparent eggs are laid on the leaves near a vein (F) or on the base of the young seeds (G). Larvae hatching from the latter burrow directly into the seed (I) and eventually destroy the contents. The larvae emerge from the seeds in early August and are believed to drop to the ground to pupate. There is one generation per year.

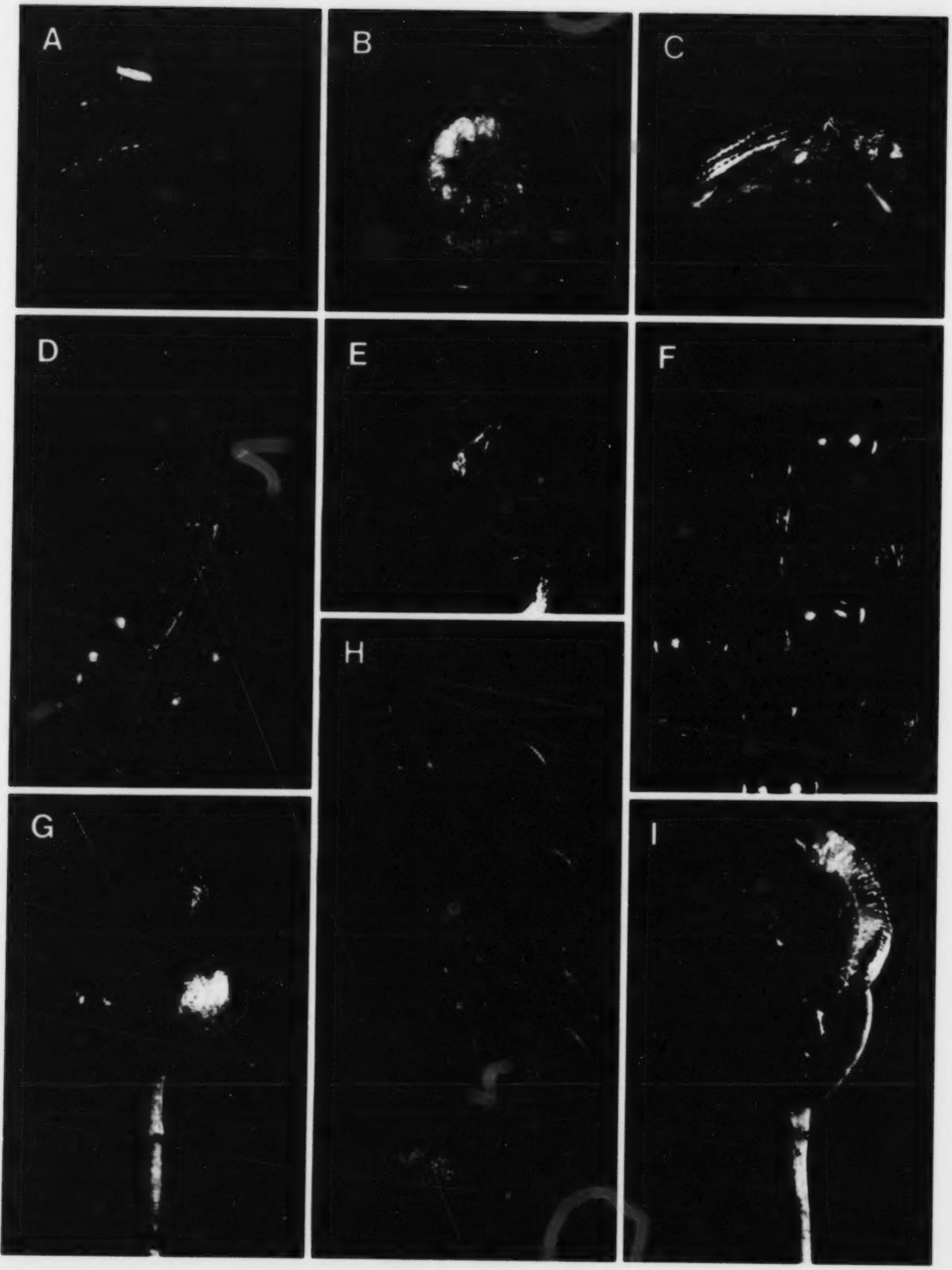
Thysanocnemis bischoffi and ***T. helvola*** have similar life cycles and are very similar in appearance. The adults of both species (not shown) are small weevils 3.2–4.0 mm in length. The females bore holes into the seeds with their snouts and deposit a single egg in each hole. The eggs hatch in about 2 days. The larvae have six instars and ultimately destroy the entire contents of the seed. They are small, legless grubs with brown heads and curved, white bodies. The larvae overwinter, either in the seeds or in the duff. *Thysanocnemis bischoffi* adults emerge more or less coincidentally with the development of the ash seeds. *Thysanocnemis helvola* adults emerge about 5 weeks later. There is one generation per year for each species.

Damage

Curculio iowensis larvae destroy all or part of acorn contents (C), destroying the viability of the seeds. ***Proteoteras* nr. *aesculana*** also kill the seeds (I), and appreciable numbers of seeds are sometimes affected (H). ***Thysanocnemis bischoffi*** and ***T. helvola*** destroy the contents of infested seeds.

Bibliography: 18, 139, 209, 210, 211, 212, 476, 646

Figure 49. Seed insects of hardwoods. A. Adult *Curculio iowensis* (Casey). **B.** *C. iowensis* larva. **C.** Bur oak acorn damaged by *C. iowensis* larval feeding. **D.** *C. iowensis* larval emergence hole in bur oak acorn. **E.** Adult *Proteoteras* nr. *aesculana* Riley. **F.** *P.* nr. *aesculana* egg (at arrow) on Manitoba maple leaf. **G.** *P.* nr. *aesculana* eggs (at arrows) and damage to Manitoba maple seeds. **H.** Manitoba maple seeds infested with *P.* nr. *aesculana*. **I.** Manitoba maple seed opened to show young *P.* nr. *aesculana* larva and damage.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FRUIT INSECTS (Figure 50)

Distribution, Hosts, and Importance

A variety of insects feed on the fruits of choke cherry and saskatoon in the prairie provinces. The most common of these are the sawfly ***Hoplocampa lacteipennis*** Rohwer, and the shadbush sawfly, ***H. halcyon*** (Norton), which infest the fruits of choke cherry and saskatoon, respectively. Another common insect is the choke cherry midge, ***Contarinia virginianae*** Felt, which sometimes destroys the fruit of choke cherry. Less common species include the apple curculio, ***Tachypterellus quadrigibbus*** Say, and another weevil, ***Pseudanthonomus crataegi*** Walsh. Adults and larvae of both insects feed on the fruit of saskatoon.

None of these insects are of economic importance, although *H. lacteipennis* and *H. halcyon* may reduce the yields of fruit on choke cherry and saskatoon, respectively. *Hoplocampa halcyon* may be of economic importance if commercial plantings of saskatoon are established.

Life Cycle and Appearance

Hoplocampa lacteipennis has one generation per year and overwinters as larvae in silken cocoons in the soil. Pupation occurs in early spring, and the adult sawflies emerge in late May when the choke cherry flowers are starting to open. The adults (A) feed on the pollen and nectar. They are yellow in color and are 5–6 mm long. After mating, the females deposit eggs into slits cut into the calyxes. The first-instar larvae destroy the contents of the fruit in about 1 week, then molt and enter a second fruit. The second-instar larvae bore tunnels on the outside of the pits for about 3 weeks before entering them. Development through the remaining three larval instars is completed in the second fruit in 5 or 6 weeks. The third and fourth instars each last about 8–10 days. Fully developed larvae (B) are whitish with yellow heads and are 8–9 mm long. They bore a hole to the outside of the fruit in late July and drop to the ground, where they spin a cocoon a few centimetres below the surface.

The life cycle of ***H. halcyon*** is very similar to that of *H. lacteipennis*. The small (about 4 mm long) yellowish adults emerge when the saskatoons are beginning to bloom. The females lay eggs in the sepals, usually one per fruit. The larvae have five instars and destroy three fruits each during the course of their development. Late-instar larvae (I) are creamy-white with brown heads and have dark markings on the dorsal area of the last three abdominal segments. Fully developed larvae are about 9 mm long.

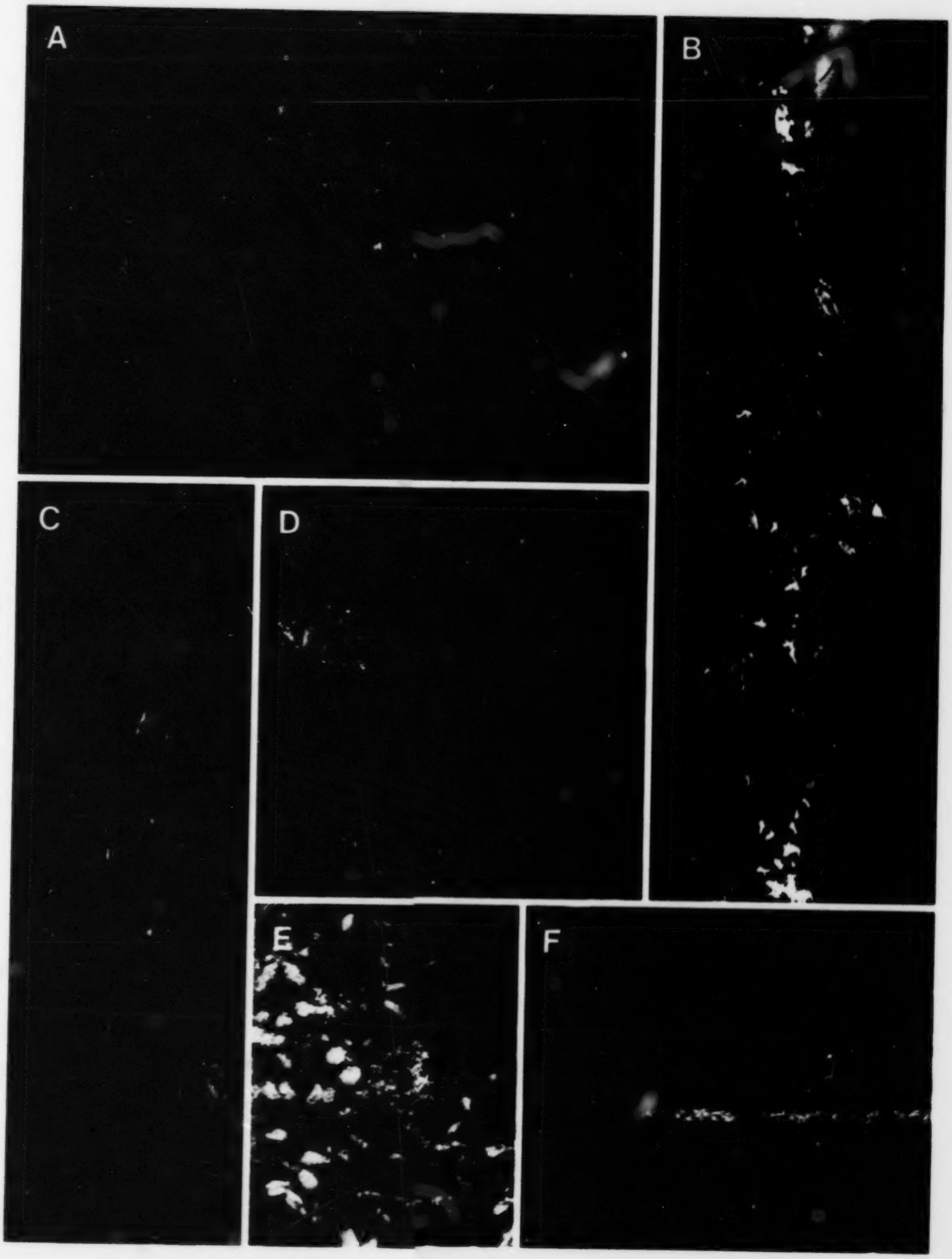
Little is known about the life cycles of ***T. quadrigibbus*** or ***P. crataegi*** in the prairie provinces. Both are small, brown weevils (C, E) that overwinter as adults in the duff and are believed to have only one generation per year. Eggs are laid in punctures cut into the fruits, and the larvae feed within the fruits. The larvae are white, legless grubs with brown heads. Both species probably have four larval instars, but it is not known how many fruits each larva destroys. *Tachypterellus quadrigibbus* adults emerge from the fruits in mid-August, and *P. crataegi* adults emerge in late August or early September.

Damage

Hoplocampa lacteipennis larvae puncture the green fruits of choke cherry (D), and this causes the fruits to shrivel when ripe (F). ***Hoplocampa halcyon*** extrudes frass through the side of the fruit (G), and damaged fruit are hollowed out and mummified (I). ***Tachypterellus quadrigibbus*** adults puncture many saskatoon fruits while feeding, so that relatively small numbers are capable of inflicting appreciable damage. Larvae of both weevil species cause the affected fruits to mummify. ***Contarinia virginianae*** larvae destroy the seeds of choke cherry and cause the hollowed-out fruits to become enlarged and pear shaped (H).

Bibliography: 42, 43, 82, 83, 140, 234, 235, 549

Figure 50. Fruit insects. A. Adult *Hoplocampa lacteipennis* Rohwer. **B.** *H. lacteipennis* larva in choke cherry. **C.** Adult *Pseudanthonomus crataegi* Walsh. **D.** Green choke cherries heavily infested with *H. lacteipennis*. **E.** Adult apple curculio, *Tachypterellus quadrigibbus* Say. **F.** Ripe choke cherries damaged by *H. lacteipennis*. **G.** Saskatoon fruit infested with the shadbush sawfly, *H. halcyon* (Norton). **H.** Two choke cherries infested by larvae of the choke cherry midge, *Contarinia virginianae* Felt. Note difference in size and shape between infested (lower) and healthy (upper) fruits. **I.** *H. halcyon* larva on saskatoon fruit sliced open to show internal damage.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APHIDS ON HARDWOODS (Figure 51)

Distribution, Hosts, and Importance

Aphids attack a wide variety of hardwoods. Most species can be identified only by a taxonomic specialist, but a few can be recognized on the basis of their host-specific association.

Hyadaphis tataricae (Aizenberg) feeds on various species of honeysuckle. It is a recent introduction into North America and was first reported from the province of Quebec in 1981. The insect was probably introduced into the Montreal area about 1975. It has now spread as far west as Alberta. The insect probably originated in northern and western Asia, as this is the area where honeysuckle grows naturally. *Hyadaphis tataricae* appears to have the potential of being a major pest in ornamental plantings.

The caragana aphid, ***Acyrthosiphon caraganae*** (Cholodkovsky), is found almost exclusively on common caragana in the prairie provinces. Caragana is native to southwestern Russia, and the caragana aphid is believed to have been accidentally introduced into North America from there during the latter part of the 19th century. Heavy infestations occur periodically on caragana shelterbelts, particularly in southern Saskatchewan and Alberta.

The boxelder aphid, ***Periphyllus negundinis*** (Thomas), attacks only Manitoba maple (box elder) and is common throughout the range of its host. The witch hazel gall aphid, ***Hamamelistes spinosus*** Shimer, on white birch is another example of a leaf-feeding aphid. The smokywinged poplar aphid, ***Chaitophorus populicola*** Thomas, is an example of the many other aphid species that attack the roots and stems of various willows and poplars. Although these aphids are often very abundant, none are of economic importance except on ornamental plantings.

Life Cycle and Appearance

All of the above aphid species are able to complete their life cycle on a single host, overwintering as eggs. The eggs hatch in the spring and develop into parthenogenetic, wingless, viviparous females. The nymphs emerging from these females become winged or wingless females that also produce nymphs without mating. The winged forms may disperse to new hosts or to new sites on the same host, and dense colonies often develop as successive generations mature. Most aphids produce copious amounts of a sticky substance called honeydew. Male and female aphids develop in the fall. These mate, and the tiny females each lay a single egg on the host tissue, usually in a bark crevice.

Hyadaphis tataricae nymphs and adults produce a whitish flocculence and feed primarily on the young foliage, sucking sap from the upper surface of the leaves (D). This causes the leaves to fold upwards, forming pseudo-galls. The feeding of the aphids usually causes the shoots to droop (A) and stimulates the formation of many side shoots that are much thinner than normal. The resulting broomlike growth often dies but does not fall off the shrub.

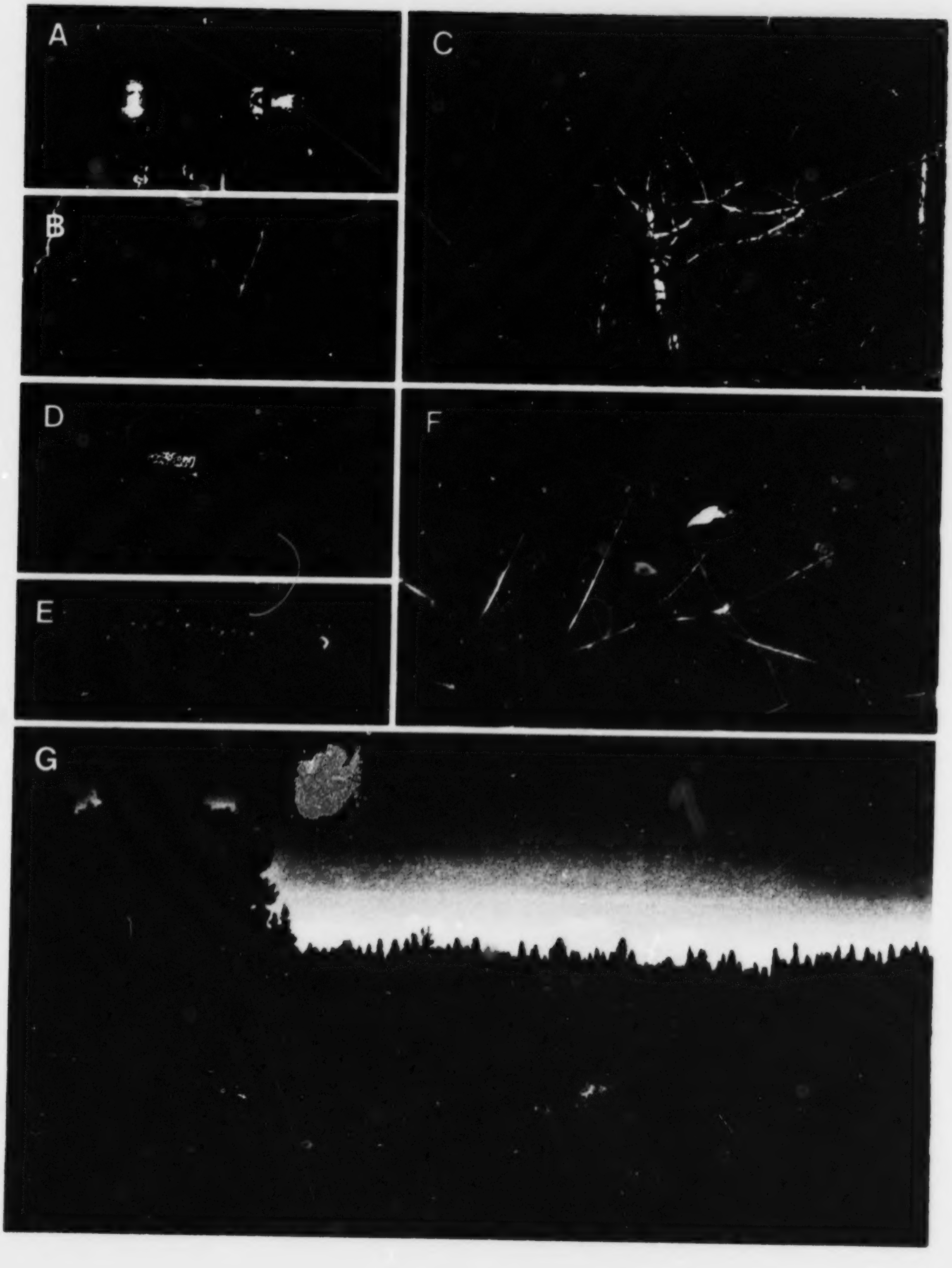
Acyrthosiphon caraganae is pale green in color (B) except for the winged males, which develop in the fall. These are reddish in color in both the nymphal and adult stages. ***Hamamelistes spinosus*** are covered with a whitish flocculence (E). ***Chaitophorus populicola*** are almost black in color (C), and ***P. negundinis*** are yellowish green (F). The latter species is interesting, because some specimens have leaflike appendages protruding from the front of the head and edges of the abdomen. The function of these appendages is not known.

Damage

The persistent, broomlike growths caused by ***H. tataricae*** detract from the appearance of the shrub, and this may limit the future use of honeysuckle in ornamental plantings. Severe infestations of ***A. caraganae*** may cause premature loss of foliage. The ants that often tend aphid colonies on willows and poplar do not adversely affect the host trees. Copious amounts of honeydew are secreted by ***P. negundinis***. This coats everything beneath the trees and is one of the factors contributing to the unpopularity of Manitoba maple as an ornamental.

Bibliography: 51, 227, 283, 309, 322, 469, 472, 473, 590, 591

Figure 51. Aphids on hardwoods. A. Deformed honeysuckle shoots caused by the feeding of *Hyadaphis tataricae* (Aizenberg). **B.** Caragana aphids, *Acyrthosiphon caraganae* (Cholodkovsky), on a caragana seed pod. **C.** Smokywinged poplar aphids, *Chaitophorus populicola* Thomas, on trembling aspen stem. **D.** *H. tataricae* on young honeysuckle foliage. **E.** Witch hazel gall aphids, *Hamamelistes spinosus* Shimer, on white birch. **F.** Boxelder aphids, *Periphyllus negundinis* (Thomas), on Manitoba maple leaf.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LEAF BEETLES (Figure 52)

Distribution, Hosts, and Importance

Two leaf beetles, the American aspen beetle, ***Gonioctena americana*** (Schaeffer), and the gray willow leaf beetle, ***Tricholochmaea decora*** (Say), often cause extensive damage in the region. *Gonioctena americana* feeds on trembling aspen in both the adult and larval stages. *Tricholochmaea decora* adults feed on trembling aspen and willow, but larval feeding is apparently confined to willow. Outbreaks of both species tend to be short-lived.

Life Cycle and Appearance

The life history of ***G. americana*** has not been studied in this region. The following is a short account of its known life history. The insect overwinters as sexually immature adults in the litter and has one generation per year. The adult beetles are 5 or 6 mm long and are extremely variable in color. The elytra of some specimens are red or reddish yellow with black spots (A), but others have elytra that are almost entirely dark brown or blackish. The adult beetles emerge from hibernation more or less coincident with the full development of the aspen foliage. They eat notches in the edges of the leaves; then they mate, and the females lay clusters of eggs, containing fully developed embryos, on the underside of the leaves. The larvae emerge almost immediately and feed gregariously when young. The larvae (B) are black in color. At first they eat all but the upper epidermis, although older larvae consume the entire leaf except for the larger veins (C). Feeding lasts 3 or 4 weeks, and pupation occurs in the soil or litter in late June. Adults emerge in mid-July. They are active on the foliage for a short period, then drop to the ground and move to hibernation sites.

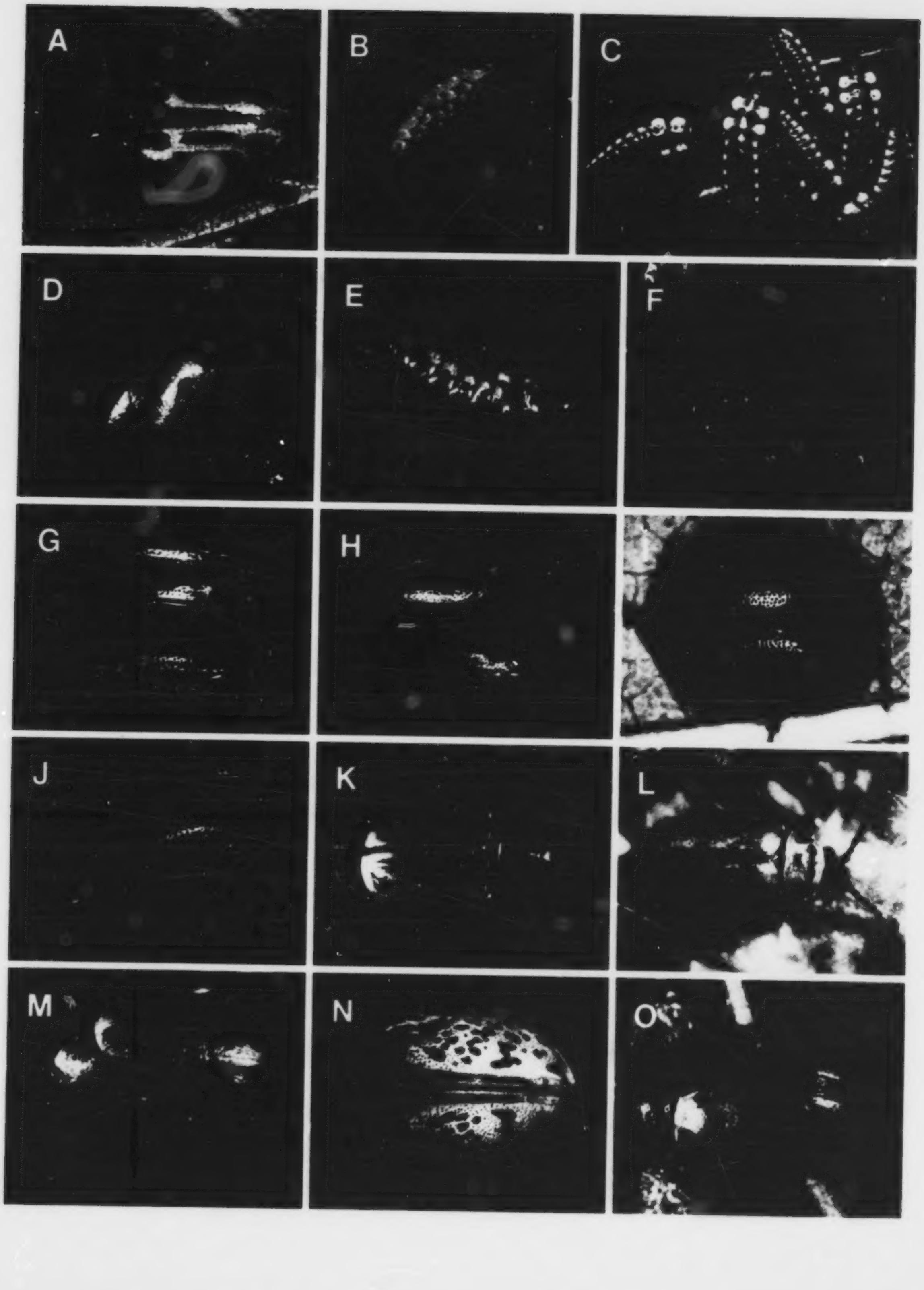
Tricholochmaea decora also overwinters as a sexually immature adult and has one generation per year. The adults are grayish to yellowish brown, occasionally almost black (D), and are about 5 mm long. They emerge from their hibernation sites in the spring and feed gregariously on poplar and willow until mid-June. They are heavy feeders, and swarms of beetles will fly long distances if there are food shortages. Oviposition occurs in late June or early July and is apparently restricted to willow. Eggs are laid in clusters covered with fecal matter at the base of willow bushes, usually on rough bark. The bodies of the larvae are light yellow with a dark dorsal stripe and dotted lateral lines (E). They have black heads and are about 8–10 mm long when fully grown. The larvae skeletonize the leaves while feeding (F), eating all but the upper epidermis and veins. Pupation occurs in the soil or litter in late July or early August, and the adults emerge in about 2 weeks. They feed briefly, then enter the litter to hibernate.

Damage

Neither ***G. americana*** nor ***T. decora*** appear to cause serious injury to their hosts, even during severe infestations. The feeding damage causes the trees to have a scorched appearance and renders them unsightly (G), however. Outbreaks usually subside before any appreciable branch or tree mortality occurs.

Bibliography: 74, 127, 203, 292, 370, 441, 476, 478, 615, 616

Figure 52. Leaf beetles. A. Adult American aspen beetle, *Gonioctena americana* (Schaeffer). **B.** *G. americana* larvae. **C.** Small trembling aspen defoliated by *G. americana*. **D.** Adult gray willow leaf beetle, *Tricholochmaea decora* (Say). **E.** *T. decora* larva. **F.** Close-up of larval feeding by *T. decora*. **G.** Scorched appearance of willow foliage following feeding damage by *T. decora*.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THE COTTONWOOD LEAF BEETLE AND ITS ALLIES (Figure 53)

Distribution, Hosts, and Importance

The cottonwood leaf beetle, ***Chrysomela scripta*** Fabricius, and the aspen leaf beetle, ***Chrysomela crotchi*** Brown, occasionally cause extensive damage. *Chrysomela scripta* attacks various poplars, particularly hybrids, and willow, but does not feed on trembling aspen. *Chrysomela crotchi* feeds primarily on trembling aspen but will sometimes attack other poplars. Outbreaks of both species have occurred throughout the region. Other species of leaf beetles are frequently encountered, but all are difficult to identify, and none are economically important.

Life Cycle and Appearance

The life history of ***C. scripta*** has not been studied in this area. It apparently overwinters as a sexually immature adult and has two generations per year in the prairie provinces. Adult beetles (A) are between 6 and 9 mm long. The head is almost black, the dorsal part of the pronotum is usually dark, and the lateral parts are pale reddish, each with a dark spot. The elytra are yellowish with a dark line along the inner edges (middorsal with wings closed), and each has seven elongate dark spots. Adults emerge from hibernation when the leaves first appear and begin feeding immediately. The yellow eggs (B) are laid in clusters on the leaves. The mature larvae (C) are about 12 mm long, have black heads, brownish thoracic shields, well-developed thoracic legs, yellowish bodies with two rows of black spots along the back, and dark-colored eversible glands along each side of the abdomen. They skeletonize the underside of the leaves and complete their feeding in about 2 weeks. The pupae hang from the leaves by an anal disk. Adults emerge in about 1 week. Summer generation adults soon mate and repeat the cycle. Overwintering adults drop to the litter and enter hibernation.

Chrysomela crotchi also overwinters as sexually immature adults but has one generation per year. The adults (D) are about 7 or 8 mm long, and they emerge in late May or early June. The head and pronotum are black, and the elytra are uniformly light brown or brownish yellow. Young larvae are almost black, and older larvae (E) resemble those of the cottonwood leaf beetle but are whiter. They are about 13 mm long when fully grown. Young larvae skeletonize the undersides of the leaves, and older larvae eat all but the larger veins (F). Pupation occurs in late July, and the adults emerge about a week later. They have a short period of activity, then enter the litter to hibernate.

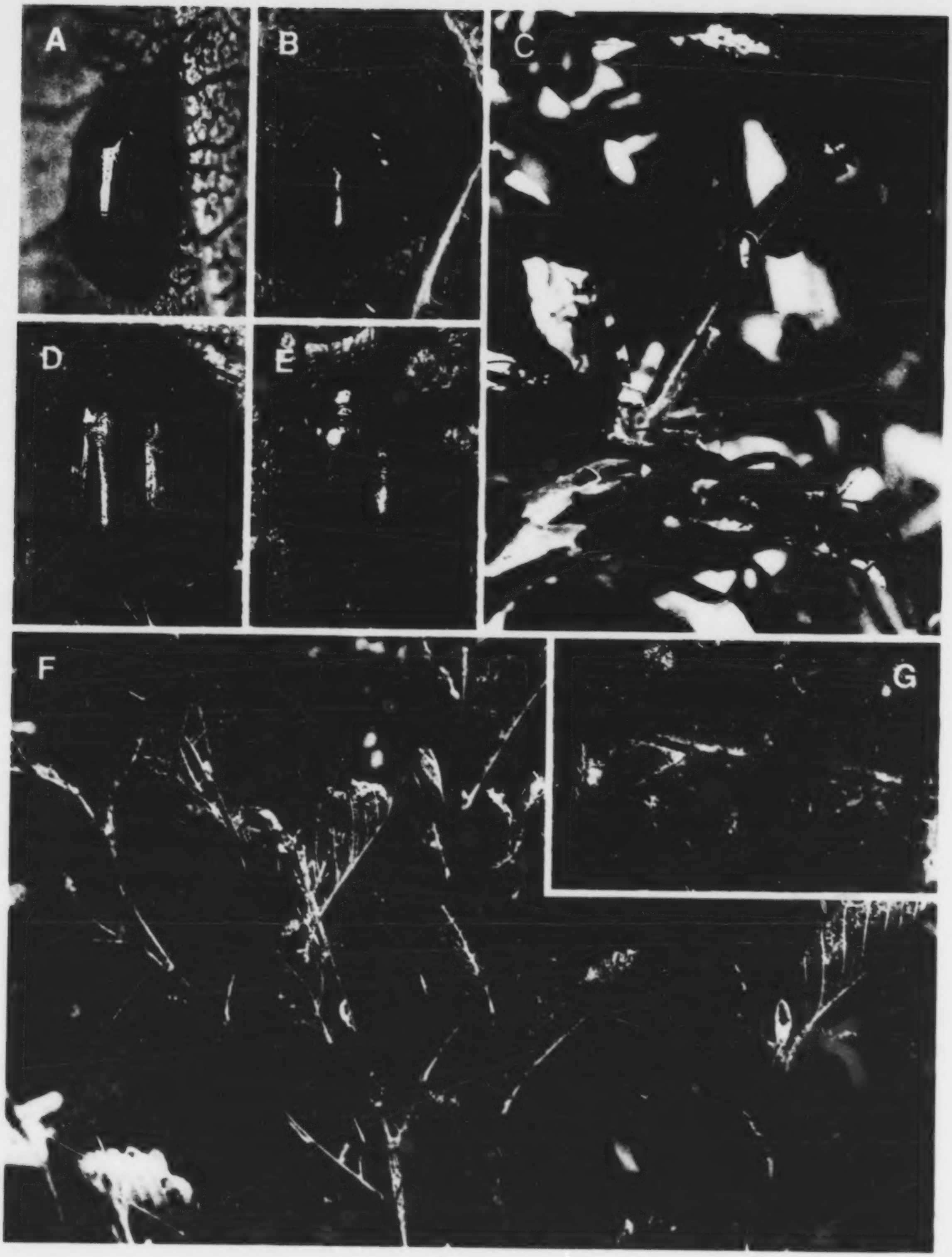
Seven other species of *Chrysomela* occur in the region. All have reddish or yellowish elytra, variously marked with black bars or spots. Examples are as follows: the alder leaf beetle, ***C. mainensis*** Bechyné (G), which feeds primarily on alder; ***C. semota*** Brown (H), which feeds on willow, balsam poplar, and black cottonwood; the spotted willow leaf beetle, ***C. knabi*** Brown (I), on poplar and willow; and ***C. falsa*** Brown (J) on balsam poplar. ***Pachybrachis bivittatus*** Say (K), on willow, has whitish elytra marked with black stripes and spots. The genus *Disonycha* also contains a large number of species, all of which have striped elytra. ***Disonycha alternata*** (Illiger) (L), on willow, is typical. *Calligrapha* is another large genus that has cream colored or whitish elytra variously marked with black spots or lines. ***Calligrapha verrucosa*** (Suffrian) (M) and ***C. multipunctata multipunctata*** (Say) (N) on willow and ***C. ignota*** Brown (O) on birch are typical of the genus.

Damage

Chrysomela scripta prefers young foliage. Heavy populations often kill the leaders, causing deformed growth. The insects are particularly troublesome in plantations of hybrid poplars and in nursery stooling beds, where their feeding seriously reduces the yield of cuttings. Feeding by ***C. crotchi*** or any of the other species causes little permanent damage.

Bibliography: 49, 74, 75, 77, 84, 127, 139, 240, 247, 248, 519

Figure 53. The cottonwood leaf beetle, *Chrysomela scripta* Fabricius, and its allies. **A.** Adult *C. scripta*. **B.** *C. scripta* eggs. **C.** *C. scripta* larvae. **D.** Aspen leaf beetle, *C. crotchi* Brown. **E.** *C. crotchi* larva. **F.** *C. crotchi* feeding damage. **G.** Alder leaf beetle, *C. mainensis* Bechyné. **H.** Adult *C. semota* Brown. **I.** Spotted willow leaf beetle, *C. knabi* Brown. **J.** Adult *C. falsa* Brown. **K.** Adult *Pachybrachis bivittatus* Say. **L.** Adult *Disonycha alternata* (Illiger). **M.** Adult *Calligrapha verrucosa* (Suffrian). **N.** Adult *C. multipunctata multipunctata* (Say). **O.** Adult *C. ignota* Brown.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FLEA BEETLES AND THEIR ALLIES (Figure 54)

Distribution, Hosts, and Importance

Flea beetles are small insects with hind legs suited for jumping. Most species are agricultural or horticultural pests, but a few attack forest trees and shrubs. Other small bluish black leaf beetles also feed on forest trees and shrubs. Examples of both groups will be discussed.

The genus *Phratora* contains a number of leaf beetles that are transcontinental in distribution. ***Phratora frosti remissa*** Brown is typical of the genus. It feeds on willow and poplar. An unidentified flea beetle on elm, ***Altica*** sp. (the genus needs revision), is typical of the small flea beetles that feed on various trees and shrubs. The alder flea beetle, ***A. ambiens*** LeConte, is a widely distributed species that feeds on various alders. Severe localized infestations have occurred periodically in the prairie provinces. ***Altica populi*** Brown, on balsam poplar, and ***A. bimarginata*** Say, on willow, have occasionally caused severe leaf skeletonizing in localized areas, particularly in southern Saskatchewan. None of these insects are of economic importance.

Life Cycle and Appearance

The life cycles of all of these beetles are similar, as far as is known. There is one generation per year, with overwintering occurring in the adult stage. Adults emerge from hibernation in the spring, mate, and lay eggs in clusters on the underside of the leaves or on the stems. The larvae feed gregariously, skeletonizing the foliage. The insects are difficult for anyone but a specialist to identify. Adult *Phratora* can be separated from flea beetle adults by the punctations or depressions in their elytra. The elytra of the flea beetles are smooth. Host associations aid in separating the adults and larvae in each group.

Phratora frosti remissa adults are about 5 mm long (A). They have conspicuous rows of elytral punctations and are usually coppery above, but some specimens are purple or blue. Adults of the ***Altica*** species feeding on elm are shiny, bluish beetles about 4 mm long (B). ***Altica bimarginata*** (C), ***A. populi*** (D), and ***A. ambiens*** (E) adults are almost identical. All are shiny steel blue beetles about 6 mm long. The larvae (G) are black, and they skeletonize the foliage. The life cycle of ***A. bimarginata*** will serve to illustrate the group.

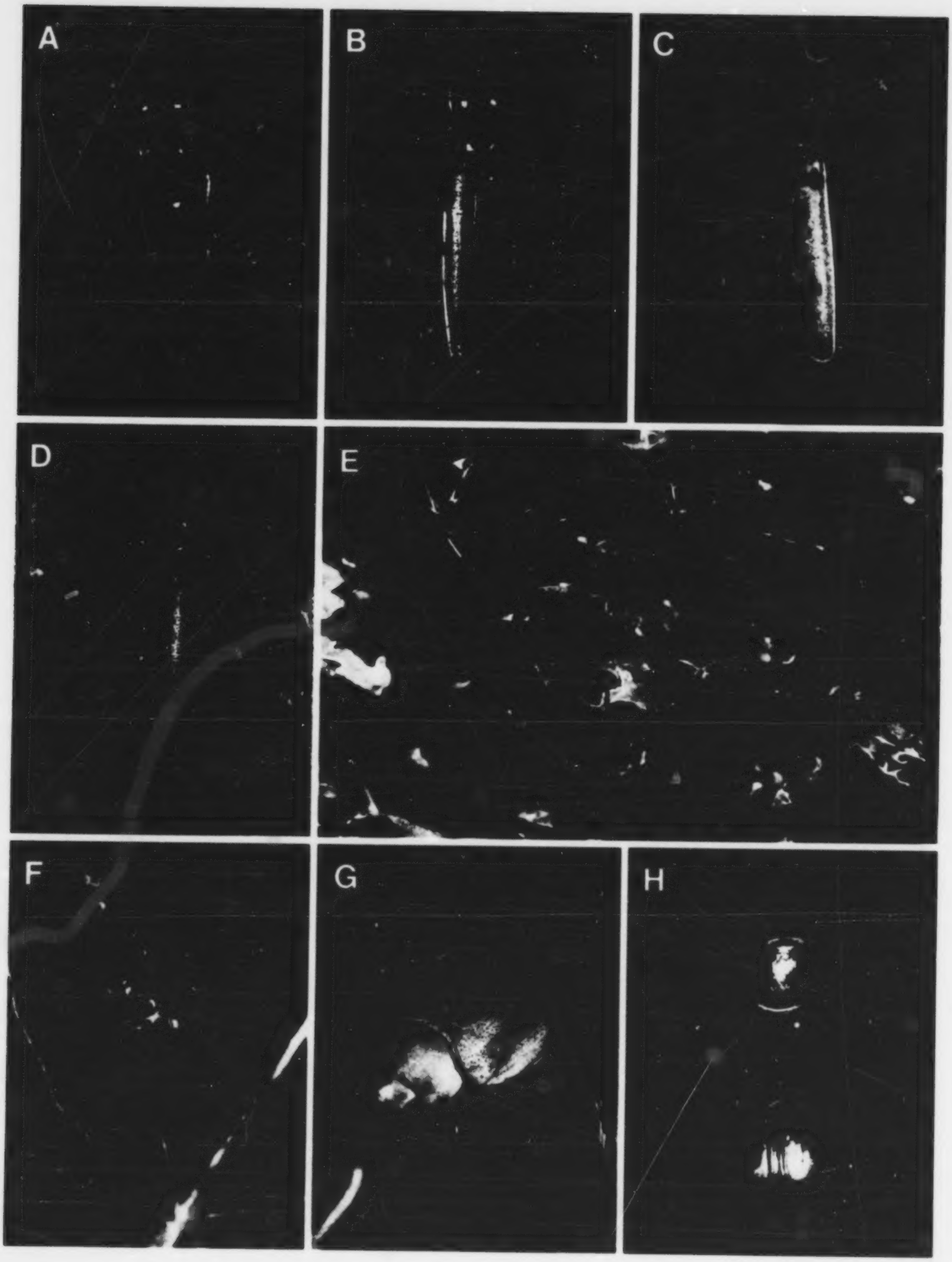
The overwintering adults of ***A. bimarginata*** emerge from hibernation before the willow foliage has flushed and have been observed feeding on the foliage of wild rose at this time. The beetles migrate to willow as soon as the foliage develops. Older beetles tend to lose their shine and are darker in color than newly emerged beetles. The beetles are gregarious and move around on the willow bushes in groups (C). The overwintered beetles are active until late July or early August, and then they die. The females lay batches of eggs over an extended period. Most eggs are laid on the stems of the willows, but some small clusters are deposited on the leaves. There are three larval instars. All but freshly molted larvae are dark brown or black in color. The larvae skeletonize the foliage and drop to the ground when feeding is completed. Pupation occurs in cells formed in the soil by the larvae, and the adults emerge during August or early September. The adults feed on willow foliage for several weeks before hibernating in groups in the duff, usually at the base of a plant.

Damage

The adult beetles eat holes in the leaves. This causes very little damage to the host unless populations are very heavy. The larvae skeletonize the leaves of their hosts, however, and this causes the foliage to assume a scorched appearance (F). The affected trees or bushes are very unsightly, particularly in a parkland setting, but little permanent damage is caused.

Bibliography: 20, 50, 73, 76, 656

Figure 54. Flea beetles and their allies. A. Adult *Phratora frosti remissa* Brown. **B.** Adult *Altica* species on white elm. **C.** Group of adult *A. bimarginata* Say on willow. **D.** Adult *A. populi* Brown. **E.** Adult alder flea beetle, *A. ambiens* LeConte. **F.** Alder foliage skeletonized by the feeding of *A. ambiens*. **G.** *A. ambiens* larvae.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BLISTER BEETLES AND SCARABS (Figure 55)

Distribution, Hosts, and Importance

Blister beetles and scarabs are members of two large families in which the adults, but not the larvae, feed on the foliage of a wide variety of plants, including several species of trees and shrubs. A few examples of each group will be discussed.

Blister beetles occur in the southern part of the prairie provinces, particularly in Saskatchewan and Alberta. The Nuttall blister beetle, ***Lytta nuttalli*** Say, the ashgray blister beetle, ***Epicauta fabricii*** (LeConte), and ***Lytta viridana*** LeConte will feed on young caragana foliage. The ash blister beetle, ***Lytta sphaericollis*** Say, will feed on western snowberry, honeysuckle, and green ash. None are of economic importance, but the beetles travel in swarms and can quickly defoliate a small tree or shrub.

Three examples of scarabs will serve to illustrate this group, none of which are of economic importance in the adult stage. ***Dichelonyx subvittata*** LeConte feeds on white birch; the goldsmith beetle, ***Cotalpa lanigera*** (Linnaeus), is found on willow and poplar; and the common June beetle, ***Phyllophaga anxia*** (LeConte), attacks a wide range of hardwoods. Other June beetles that occur in the prairie provinces, but are not shown, include *P. rugosa* (Melsheimer), *P. drakii* (Kirby), and *P. nitida* (LeConte). They have all been reported from southern Manitoba and Alberta and feed on willows and other hardwoods. The larvae of June beetles, known collectively as white grubs (Fig. 47), are occasionally serious pests in young pine plantations.

Life Cycle and Appearance

Blister beetles are believed to have one generation annually. The adults are active during the spring and summer and live for a month or more. They can be separated fairly accurately on the basis of color (A–E), but hybridization occurs between the three ***Lytta*** species, and positive identification is difficult on this basis alone. Eggs are laid in batches in firm, moist soil. As far as is known, all blister beetle larvae feed on wild bee larvae or grasshopper egg pods. There are several unusual adaptations that enable the larvae to survive as predators in a frequently dry environment. First-instar larvae are slender, with well developed thoracic legs. They are very active while searching for food and can live for a month or more without feeding. The larvae become grublike after a food source is found and complete their development through several instars in about 3 weeks. Most species then lose all appendages and overwinter in a form that is analagous to a fly puparium. In the spring, instead of developing into an adult, the larvae molt and once again become grublike. The grubs do not feed but soon develop into pupae and then into adults.

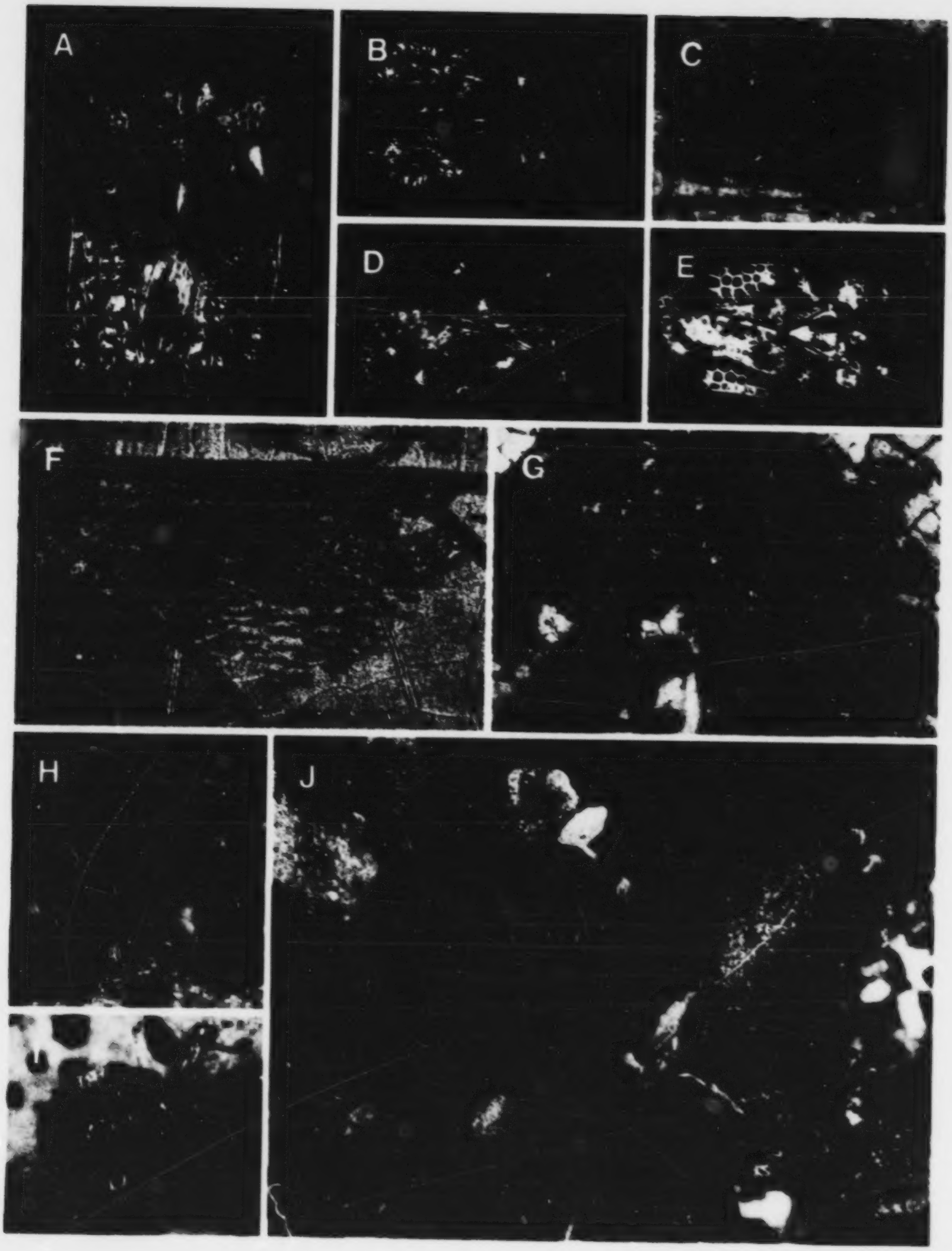
There are more than 30 species of *Dichelonyx*. All are elongate beetles, and many have shiny, metallic green elytra. ***Dichelonyx subvittata*** is typical of the genus (F). ***Cotalpa lanigera*** is the sole representative of this genus (G). Larvae of both species feed on the roots of various shrubs and grasses. All four species of *Phyllophaga* occurring in the prairie provinces are similar in appearance and have similar life histories. They are stout-bodied beetles that range in color from light brown to almost black. ***Phyllophaga anxia*** is usually the most common and is typical of the genus (H). Each generation requires 4 years to complete its development in this area, but broods are not completely synchronized, so that some adults are present each year. The larvae (Fig. 47) feed on the roots of grasses and herbs and are creamy-white with light brown heads. They have a typical C-shaped, curved body and reach a length of about 40 mm when fully grown. Completion of larval development requires 3 years, and the larvae move deep into the soil to overwinter. Pupation occurs in late spring. Adults develop soon afterwards but remain in the soil until the following spring when they emerge, mate, and lay eggs.

Damage

Heavy feeding by blister beetles has caused mortality in young caragana shelterbelts, but no other significant damage has been reported for any of these beetles. White grubs (Fig. 47) have killed trees in newly planted pine plantations.

Bibliography: 100, 101, 114, 139, 223, 294, 331, 341, 431, 470, 506, 507, 543

Figure 55. Blister beetles and scarabs. A. Adult *Lytta viridana* LeConte. **B.** Ash blister beetle, *L. sphaericollis* Say. **C.** Ashgray blister beetle, *Epicauta fabricii* (LeConte). **D.** Nuttall blister beetle, *L. nuttalli* Say. **E.** *L. nuttalli* feeding on caragana. **F.** Adult *Dichelonyx subvittata* LeConte. **G.** Goldsmith beetle, *Cotalpa lanigera* (Linnaeus). **H.** Common June beetle, *Phyllophaga anxia* (LeConte).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LACE BUGS (Figure 56)

Distribution, Hosts, and Importance

The lace bugs are a family of true bugs in which the adults have a lacelike appearance. Most of the species feeding on hardwood trees belong to the genus *Corythucha*; they attack a limited range of hosts. Although some become locally abundant, none are of economic importance.

The oak lace bug, ***C. arcuata*** (Say), feeds on bur oak in southern Manitoba. The elm lace bug, ***C. ulmi*** Osborne & Drake, attacks white elm in southern Manitoba and has been reported to feed on Siberian elm. The hawthorn lace bug, ***C. cydoniae*** (Fitch), feeds on hawthorn and has been collected in southern Manitoba. The birch lace bug, ***C. pallipes*** Parshley, attacks birch, alder, and hazel. ***Corythucha mollicula*** Osborne & Drake was collected on willow in southern Manitoba and on balsam poplar in central Alberta. The last three species probably occur throughout the region.

Life Cycle and Appearance

The life cycles of the various species of *Corythucha* have not been studied in detail but are probably similar to that of ***C. arcuata***. This species has two generations per year in the prairie provinces and overwinters as an adult under loose bark or beneath fallen leaves. The adults (A) are small bugs, less than 3.5 mm long, that seem to be hiding under lace, an effect created by modifications of the various structures common to this group of insects. Special terminology is used for these structures in lace bugs, but only three will be referred to here. The hood is the globose structure covering the head, the median carina is the structure immediately behind the hood, and the hemelytra are the wing covers. The hood on *C. arcuata* is constricted and is about the same height as the median carina. The hemelytra are variable in color but typically have basal and apical dark bands without markings between them. The eggs (F) are laid in clusters on the underside of the leaves in early spring. They are cylindrical (H), and the young nymphs emerge in about 3 weeks by forcing off the circular end of the egg. The nymphs of all species feed gregariously (G) and deposit dark specks of tarry excrement on the underside of the leaves. There are five nymphal instars, and the nymphs (I) become more like the adults with each successive molt. Late-instar nymphs are more or less circular in outline, are blackish with light markings, and have prominent spines around the edge of the abdomen. First-generation adults emerge in midsummer, and the second generation completes its development by early fall.

Corythucha ulmi adults (B) resemble those of *C. arcuata* but have more dark markings on the hemelytra. ***Corythucha cydoniae*** adults (C) have a hood that is higher than the median carina. The posterior edge of the apical band is regular, and the markings are very dark. ***Corythucha pallipes*** adults (D) are relatively large and are about 4 mm long. The hood is large and almost spherical, the posterior edge of the apical band is irregular, and the markings are brownish. ***Corythucha mollicula*** adults (E) resemble those of *C. arcuata*, but the hood is smaller.

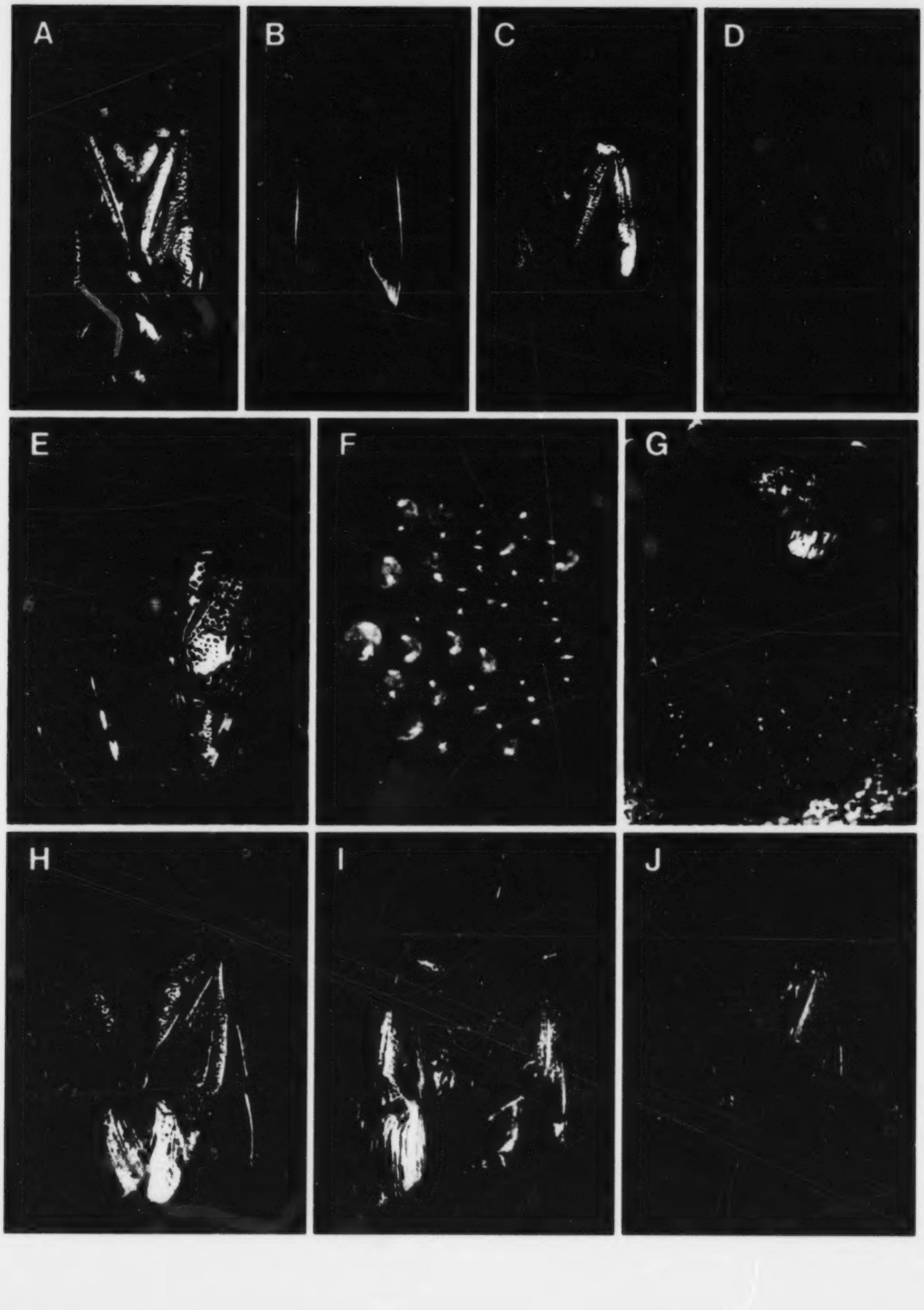
Host associations also help to separate the adults of the above species and are the only method of identifying nymphs that are not accompanied by adults.

Damage

The feeding by lace bug adults and nymphs causes a mottling of the foliage (J). The leaves become leathery and tend to drop prematurely, especially during dry weather. This injury apparently has little adverse effect on the host tree, but the discoloration and tarry excrement are objectionable in ornamental plantings.

Bibliography: 62, 109, 136, 208, 281, 436, 476, 509, 518

Figure 56. Lace bugs. A. Adult oak lace bug, *Corythucha arcuata* (Say). **B.** Adult elm lace bug, *C. ulmi* Osborne & Drake. **C.** Adult hawthorn lace bug, *C. cydoniae* (Fitch). **D.** Adult birch lace bug, *C. pallipes* Parshley. **E.** Adult *C. mollicula* Osborne & Drake. **F.** *C. arcuata* eggs and adults. **G.** *C. mollicula* nymphs and adults. **H.** Close-up of *C. arcuata* eggs. **I.** Close-up of *C. arcuata* nymph. **J.** Bur oak leaves damaged by *C. arcuata* feeding.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PLANT BUGS AND STINK BUGS (Figure 57)

Distribution, Hosts, and Importance

Plant bugs and stink bugs are a group of sucking insects that contain many species that are major pests on agricultural crops. There are some common species that feed on trees and shrubs, however.

The ash plant bug, ***Tropidosteptes amoenus*** (Reuter), attacks green ash in the prairie provinces. It is an eastern species whose range extends as far west as Alberta. The boxelder bug, ***Leptocoris trivittatus*** (Say), feeds primarily on Manitoba maple but will also attack other maples and ash. The tarnished plant bug, ***Lygus lineolaris*** (Palisot de Beauvois), is often very common and attacks a wide variety of plants, including trees and shrubs. The caragana plant bug, ***Lopidea dakota*** Knight, is a pest of common caragana.

Most stink bugs feed on various plants, including trees and shrubs, but some species prey on other insects. The plant-feeding species found on trees and shrubs include ***Elasmucha lateralis*** (Say) on birch and willow; the banasa stink bug, ***Banasa dimidiata*** (Say), on a wide variety of hosts, including birch, ash, and oak; and the redcrossed stink bug, ***Elasmostethus cruciatus*** Say, on alder. All have a transcontinental distribution but are of no economic importance. ***Chlorochroa persimilis*** Horvath (= *uhleri* Stal) is an eastern species whose range extends into Manitoba. It feeds primarily on clover and other ground vegetation but is occasionally found on willow.

Life Cycle and Appearance

There are several similarities in the life cycles of all the species discussed in this section. All obtain their nourishment by piercing the host tissues with their mouthparts and sucking liquid from the plant cells. Their young are nymphs that become progressively more like the adult with each molt. Details of the life cycle have not been worked out for many of the species.

The majority of plant bugs apparently overwinter in the egg stage, as exemplified by ***T. amoenus***. The eggs are believed to be inserted in the bark of its host in the fall. The nymphs emerge in the spring and feed on the underside of the leaves. First-generation adults (A) appear in midsummer. They are light tan in color and are about 5 mm long. Live specimens have pinkish markings. Second-generation adults appear in late summer and remain active until a severe frost occurs.

Leptocoris trivittatus overwinters in the adult stage (B). They are black insects with red markings and measure about 12 mm in length. Eggs are laid in early spring, usually on the host trees. The nymphs feed on the leaves and seeds and complete development by late summer or early fall. The adults are gregarious and seek protected hibernation sites when the weather turns cold. ***Lygus lineolaris*** has a similar life history. The adults (C) are yellowish brown to reddish brown with black markings. They are about 6 mm long. Little is known about the life cycle of ***Lopidea dakota***. The adults (D) are about 5 mm long and are reddish with a black middorsal strip and black legs. The insect probably overwinters in the egg stage.

Elasmucha lateralis adults (E) are yellowish brown stink bugs about 10 mm long. They probably have one generation per year in the prairie provinces and overwinter in the adult stage. The greenish white eggs (F) are laid in clusters on the leaves. Females have often been observed brooding over the eggs and young nymphs, apparently protecting them. Newly hatched nymphs (G) are bright red, but older nymphs are yellowish green with red markings.

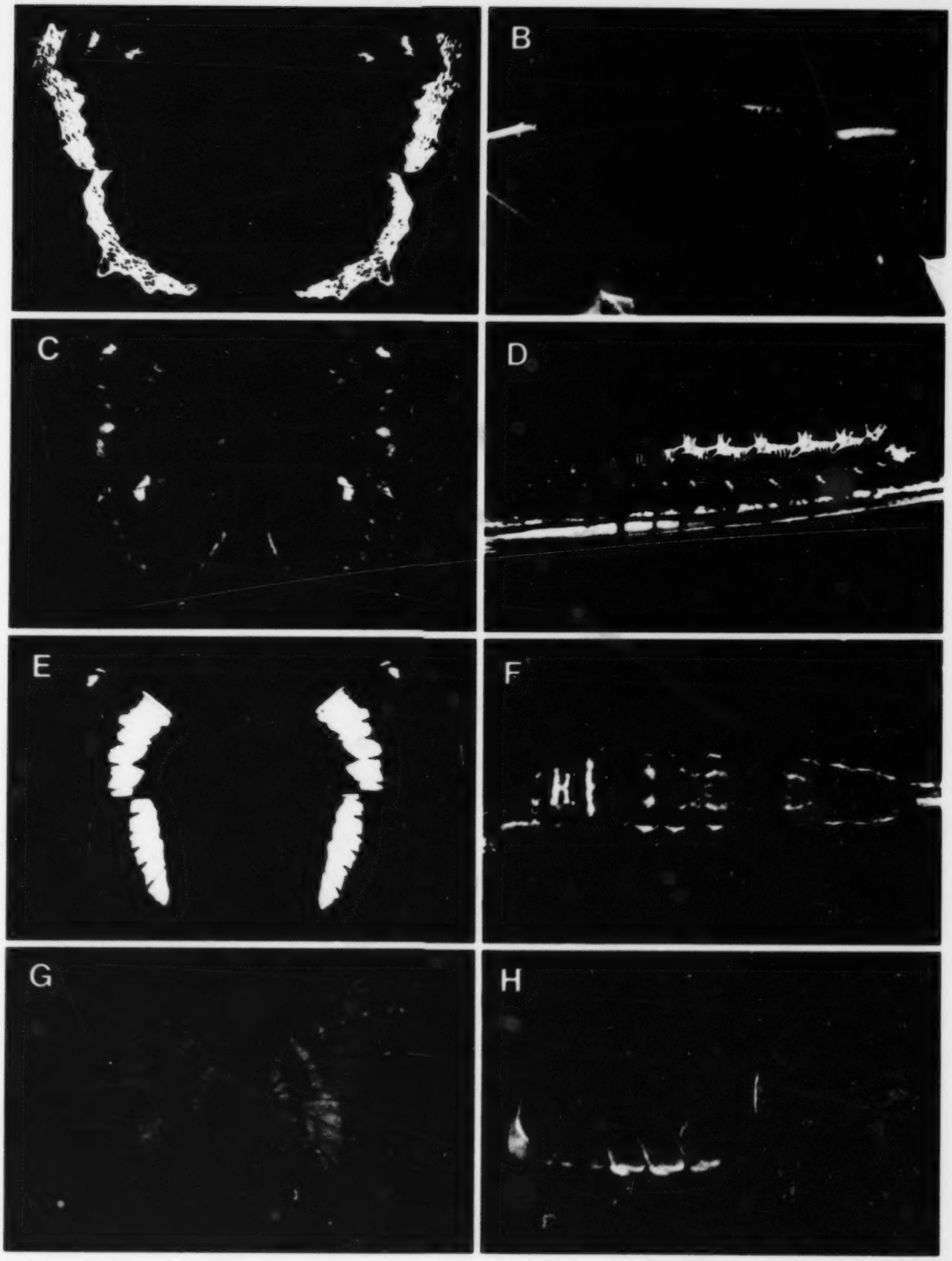
Little is known about the life histories of the other stink bugs, but they all probably have one generation per year and overwinter as adults. ***Banasa dimidiata*** adults (H) are green and brown and are 8.5–11.0 mm long. ***Elasmostethus cruciatus*** adults (I) are brownish with red marks on the front wings that form a cross when the wings are closed. ***Chlorochroa persimilis*** adults (J) are greenish and are 11–15 mm long.

Damage

The feeding damage of these sucking insects is hard to assess, as only the plant sap is removed. Severe infestations cause a mottling of the foliage, however, and may cause premature leaf drop.

Bibliography: 139, 204, 297, 307, 308, 314, 400, 476, 552, 631

Figure 57. Plant bugs and stink bugs. A. Adult ash plant bug, *Tropidosteptes amoenus* (Reuter). **B.** Adult boxelder bug, *Leptocoris trivittatus* (Say). **C.** Adult tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois). **D.** Adult caragana plant bug, *Lopidea dakota* Knight. **E.** Adult stink bug, *Elasmucha lateralis* (Say). **F.** *E. lateralis* egg mass. **G.** *E. lateralis* nymphs. **H.** Adult banasa stink bug, *Banasa dimidiata* (Say). **I.** Adult redcrossed stink bug, *Elasmostethus cruciatus* Say. **J.** Adult *Chlorochroa persimilis* Horvath (= *uhleri* Stal).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BUTTERFLIES WHOSE LARVAE FEED ON TREES (Figure 58)

Distribution, Hosts, and Importance

The larvae of a number of colorful and common butterflies feed on the foliage of various trees and shrubs in the prairie provinces, but none are of economic importance. Four examples will be discussed. The mourningcloak butterfly, ***Nymphalis antiopa*** (Linnaeus), also known as the spiny elm caterpillar, is the most common. It feeds on willow, white elm, trembling aspen, and a variety of other hosts and occasionally causes moderate-to-severe defoliation in localized infestations. The Compton tortoise-shell, ***N. vau-album j-album*** (Boisduval & LeConte), feeds on white birch, white elm, and willow but is not abundant. The white admiral, ***Basilarchia arthemis*** (Drury), feeds primarily on trembling aspen but can be found on a variety of other hosts. The familiar Canadian tiger swallowtail, ***Pterourus glaucus canadensis*** (Rothschild & Jordan), feeds on white birch, trembling aspen, willow, and other hardwoods. Although regarded as a common species, it is seldom abundant enough to be a serious pest.

Life Cycle and Appearance

Nymphalis antiopa has one generation per year and overwinters as an adult that has a wingspan of 60–80 mm (A). The body is almost black, and the wings are a rich purplish brown except for a row of blue dots, a broken whitish line and two creamy-colored spots on the leading edge of the front wing, and a creamy-colored border. The adults emerge from hibernation early in the spring and lay clusters of eggs on small twigs. The larvae are gregarious and often completely defoliate one branch before moving to another. Fully grown larvae (B) are black with numerous white dots, and they have conspicuous red dots on the first seven abdominal segments. The body is covered with numerous branched spines. The mature larvae are about 50 mm long and suspend themselves from twigs or other support before transforming to chrysalides. Adults emerge soon afterwards. ***Nymphalis vau-album j-album*** overwinters as an adult (C) that has a wingspan of 50–60 mm. The body is brown, and the wings are a mixture of orange and brown with a white spot on the front of each. The larvae (D) have black heads and black and white bodies with orange and green markings along the sides. The larvae are about 40 mm long when fully grown and have numerous branched spines on the abdomen.

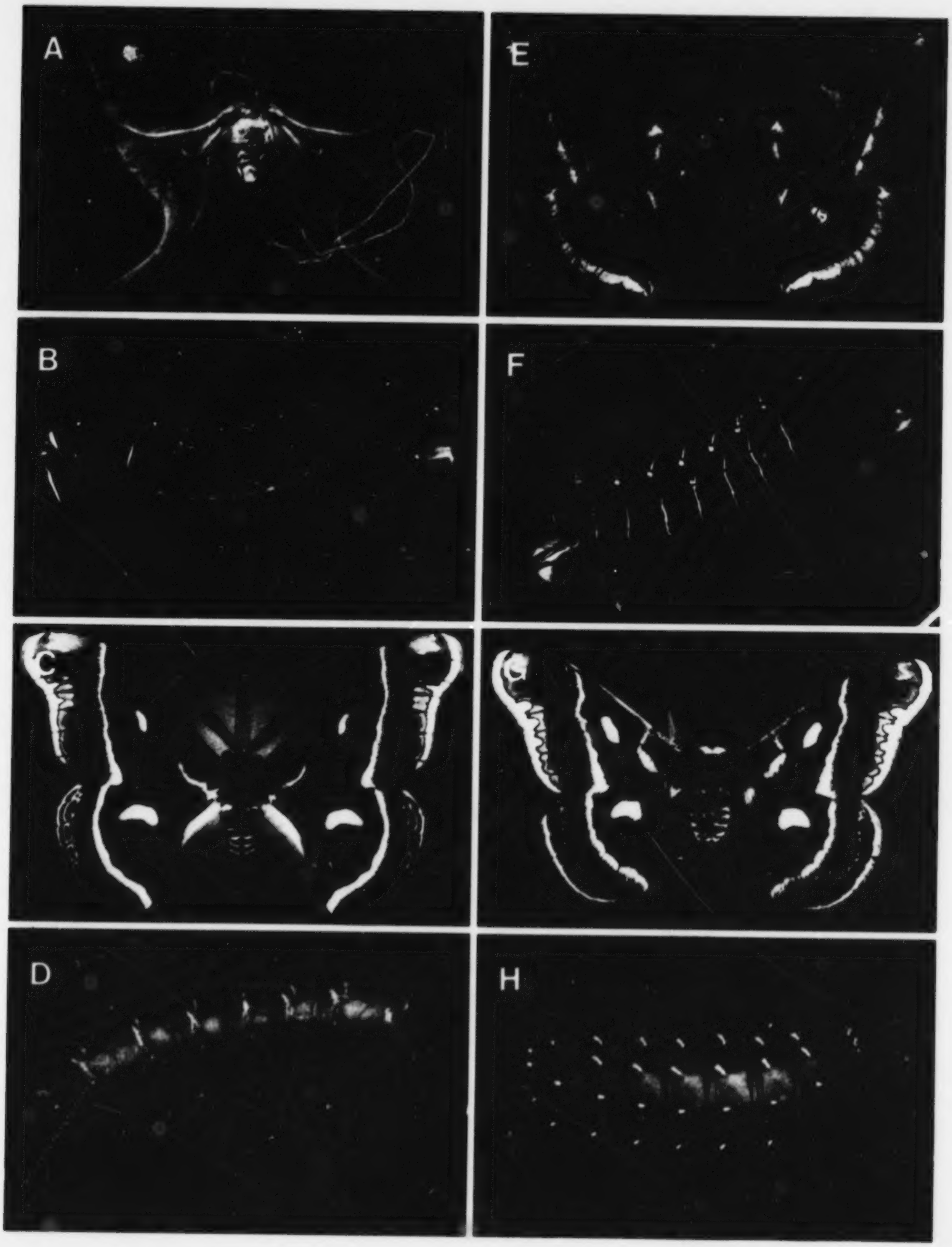
Little is known about the life cycle of ***B. arthemis*** in the prairie provinces. The adults (E) have a wingspan of about 50 mm and are a purplish black color with a conspicuous white band across each wing. The larvae (F) overwinter and are about 40 mm long when fully grown. They have conspicuous spined tubercles on the first thoracic segment. The back of the body is black with yellowish and purplish white markings. The sides of the body are whitish. ***Pterourus glaucus canadensis*** has one generation per year and overwinters in the pupal stage. The adults (G) are pretty, yellow and black butterflies with a wingspan of 70–80 mm. They are active from late May to early July and are often found near mud puddles or other sources of moisture. The larvae (H) are green with brown heads. The front part of the body is swollen and has eyespot markings on each side and a conspicuous yellow band between the thorax and abdomen.

Damage

Nymphalis antiopa, because of its gregarious habit during the larval stage, occasionally causes noticeable defoliation. Little permanent damage is likely to be done, however, unless the infestation persists for several years. The other three species are solitary feeders and are seldom if ever abundant enough to cause noticeable feeding damage.

Bibliography: 139, 297, 368, 391, 476

Figure 58. Butterflies whose larvae feed on trees. A. Mourningcloak butterfly, *Nymphalis antiopa* (Linnaeus). **B.** *N. antiopa* larva. **C.** Compton tortoise-shell, *N. vau-album j-album* (Boisduval & LeConte). **D.** *N. vau-album j-album* larva. **E.** White admiral, *Basilarchia arthemis* (Drury). **F.** *B. arthemis* larva. **G.** Canadian tiger swallowtail, *Pterourus glaucus canadensis* (Rothschild & Jordan). **H.** *P. glaucus canadensis* larva.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GIANT SILKWORM MOTHS (Figure 59)

Distribution, Hosts, and Importance

Several species of giant silkworms defoliate forest or shade trees. Larvae of the luna moth, ***Actias luna*** (Linnaeus), and the polyphemus moth, ***Antheraea polyphemus*** (Cramer), attack white birch, bur oak, willow, and a variety of other broad-leaved hosts. The range of the luna moth extends westward into Saskatchewan, and the polyphemus moth is found across Canada. No outbreaks of either species have been reported in the prairie provinces. Larvae of the cecropia moth, ***Hyalophora cecropia*** (Linnaeus), feed primarily on Manitoba maple but will attack green ash, white elm, willow, white birch, and other hosts. Widespread outbreaks have been reported on shelterbelts throughout the prairie provinces, particularly in Saskatchewan. Larvae of a closely related species, ***H. gloveri nokomis*** (Brodie), occur on willow, buffaloberry, and silverberry in the southern parts of the prairie provinces, but no outbreaks have been reported. Larvae of the io moth, ***Automeris io*** (Fabricius), feed primarily on birch and trembling aspen and are occasionally found in southeastern Manitoba.

Life Cycle and Appearance

All of the above species have one generation per year in the prairie provinces. They overwinter in the pupal stage, and the adults emerge in June or July. Adult ***A. luna*** (A) have pale green wings with a span of about 100 mm. The fore wing has an eyelike spot and a brownish purple band along the front edge. The hind wing also has an eyelike spot and a prominent curved tail. The larvae (B) are about 75 mm long when fully grown. The body is pale green, and each segment has six bristled pink or greenish tubercles. The head is blue-green, and there is a pale yellow line along the side of the body. The larvae drop to the ground when mature and spin a cocoon in the litter. ***Antheraea polyphemus*** adults (E) have a wingspan of up to 125 mm. They are buff-colored moths with conspicuous eyespots on each wing. The front edge of the fore wing is grayish, and both the front and hind wings have conspicuous purple and white bands towards their outer ends. The larvae (F) are about 75 mm long when fully grown. The body is apple green, and each segment has six bristled tubercles that are either orange or golden. The head is reddish brown.

Hyalophora cecropia moths (C) have a wingspan of 125–150 mm. The wings are purplish, and each has a conspicuous white, crescent-shaped spot near the middle and an irregular white and reddish band across the outer end. Each fore wing has a dark spot near the tip. The larvae (D) are pea green and are about 90 mm long when fully grown. Each segment has two prominent bristled tubercles: the four on the thorax are coral red, and those on the abdomen are yellow. ***Hyalophora gloveri nokomis*** moths (G) resemble cecropia moths but are smaller, with a wingspan of 90–120 mm, and the background color of the wings is reddish purple. Fifth-instar larvae (H) are about 75 mm long and are slate green in color with yellow dorsal tubercles marked with black.

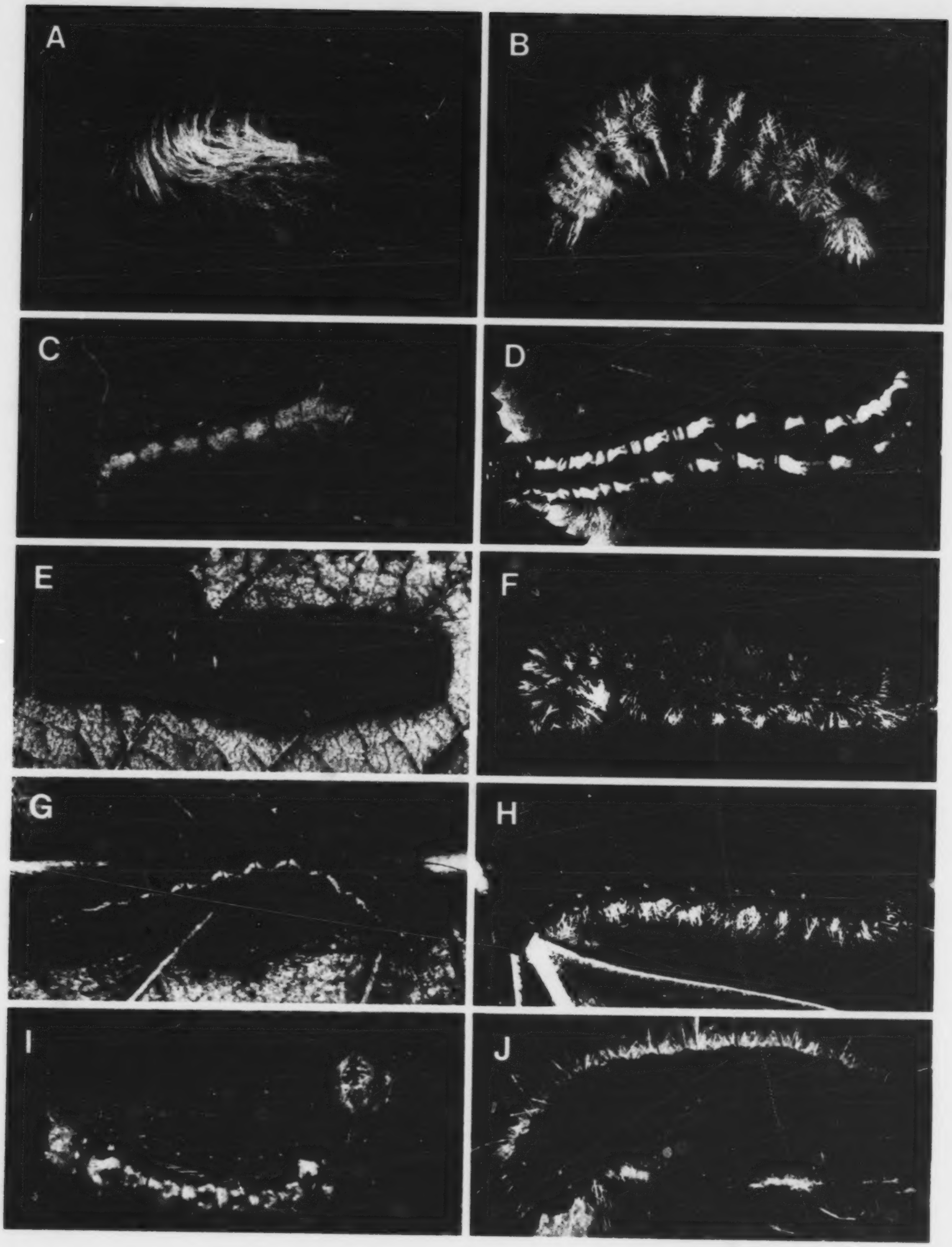
Female ***A. io*** moths (not shown) have a wingspan of 80–90 mm, and their fore wings are dark reddish brown tinged with purple. Males (not shown) have a wingspan of 55–65 mm, and the fore wings are bright yellow and sometimes tinged with brown. Hind wings of both sexes are yellow with brown inner margins and have a conspicuous dark spot near the middle, which is partially encircled by a narrow dark brown stripe and a wider light brown band. Mature larvae are green with a conspicuous red and white lateral stripe and are about 65 mm long. The body is covered with tufts of fine, branching spines that give the larvae a bristly appearance. The spines are urticatious.

Damage

These large insects damage their host trees by defoliation. ***Actias luna*** is occasionally numerous, but only ***H. cecropia*** has ever been abundant enough to cause any appreciable injury. The latter can severely reduce growth on shelterbelt trees and may cause some branch and twig mortality.

Bibliography: 106, 139, 181, 446, 476

Figure 59. Giant silkworm moths. A. Luna moth, *Actias luna* (Linnaeus). **B.** *A. luna* larva. **C.** Cecropia moth, *Hyalophora cecropia* (Linnaeus). **D.** *H. cecropia* larva. **E.** Polyphemus moth, *Antheraea polyphemus* (Cramer). **F.** *A. polyphemus* larva. **G.** Adult *Hyalophora gloveri nokomis* (Brodie). **H.** *H. gloveri nokomis* larva.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DAGGER MOTHS (Figure 60)

Distribution, Hosts, and Importance

The dagger moths are members of the large genus *Acronicta* that feed on a variety of deciduous hosts. None are of any economic importance. The American dagger moth, ***A. americana*** (Harris), feeds primarily on Manitoba maple, white birch, trembling aspen, willow, and white elm; the cottonwood dagger moth, ***A. lepusculina*** Guenée, attacks trembling aspen, black cottonwood, balsam poplar, willow, and white birch. Other relatively common species are the gray dagger moth, ***A. grisea*** Walker; the alder dagger moth, ***A. dactylina*** Grote; the poplar dagger moth, ***A. leporina*** (Linnaeus); and the birch dagger moth, ***A. innotata*** Guenée. The hosts vary with species, but all attack white birch, willow, trembling aspen, and speckled alder. Other rare species found in the prairie provinces include the cherry dagger moth, ***A. hasta*** Guenée, on choke cherry, and ***A. quadrata*** Grote, on pin cherry, choke cherry, and saskatoon.

Life Cycle and Appearance

Adult dagger moths lack distinguishing features and resemble adult cutworms. They are usually stout-bodied insects with light to dark gray wings. The wings are variously marked with darker gray or black lines, some of which resemble daggers; hence the name dagger moth. There is usually one generation per year. The larvae are easier to recognize, as there are greater differences between species. Mature ***A. leporina*** larvae (A) are about 40 mm long. They have pale green heads and greenish white bodies but are so heavily covered with white or yellow hairs that neither are usually visible. ***Acronicta americana*** larvae (B) are about 50 mm long when mature and have black heads and pale bodies densely covered with long white or yellowish hairs. They have paired pencils of long black hairs on the first and third abdominal segments and a single pencil on the eighth segment. ***Acronicta lepusculina*** larvae (C) are about 40 mm long when mature and have smooth black heads that are sometimes marked with brown. Their bodies are pale or black and are densely covered with long white or yellowish hairs. There are middorsal black pencils on most abdominal segments. Mature ***A. quadrata*** larvae (D) are about 40 mm long and have reddish heads and black bodies sparsely covered with white hairs. There is a middorsal black stripe along the length of the body that contains six prominent reddish keyhole markings and is bordered by two subdorsal white bands. Mature ***A. grisea*** larvae (E) are about 30 mm long and have mottled brown heads and green bodies with a middorsal purplish brown stripe that widens in the middle of the abdomen to enclose a central green patch. Body hairs are sparse.

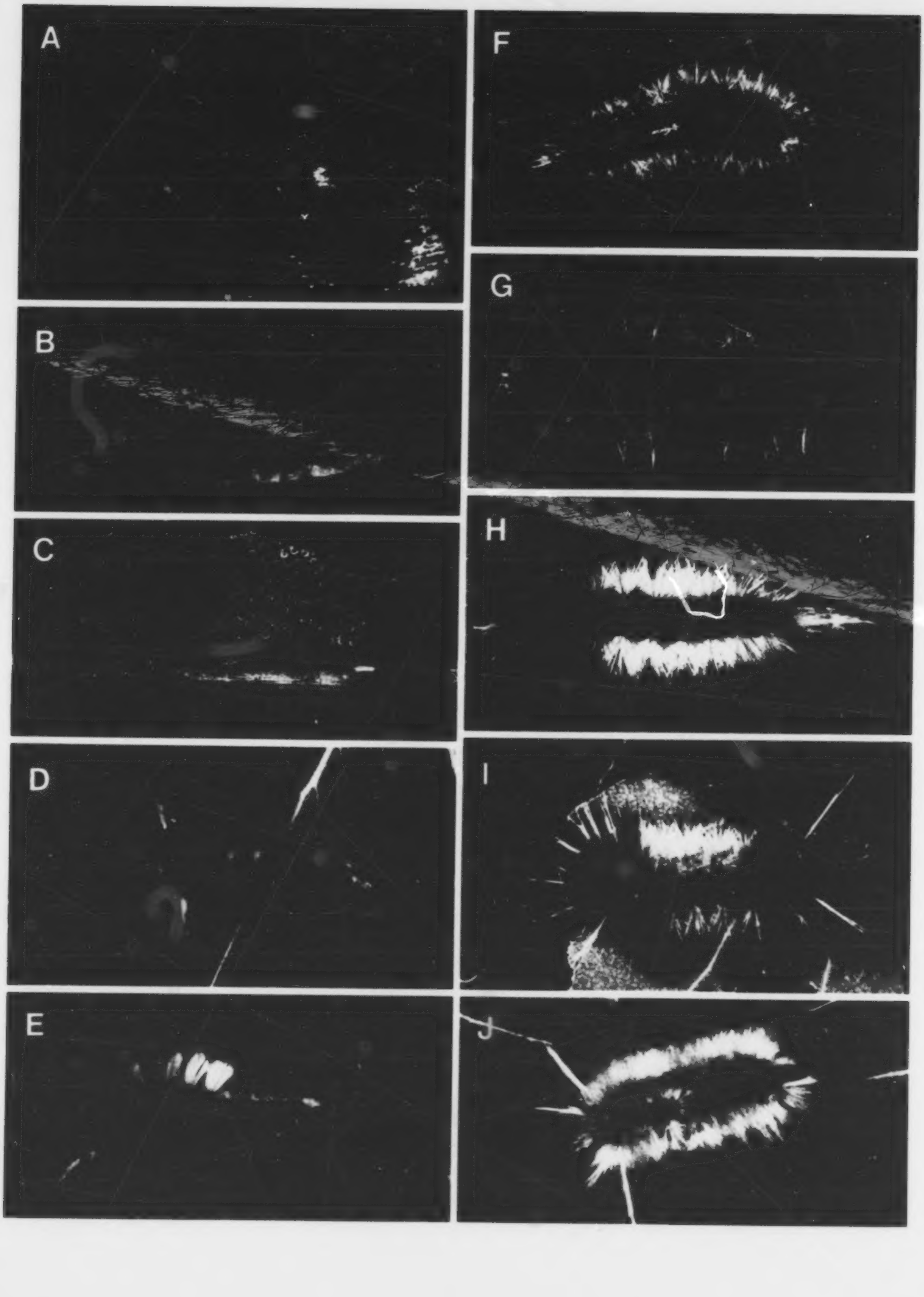
Mature ***A. dactylina*** larvae (F) are about 40 mm long and have black heads and bodies densely covered with brown dorsal hairs and white or yellowish lateral hairs. There are black middorsal pencils on the first, third, and eighth abdominal segments. Young ***A. innotata*** larvae (G) are pale green and are sparsely covered with hairs. They have a broken purplish brown dorsal band and broken subdorsal pale bands. Mature larvae (H) are about 30 mm long. They have purplish black heads with two orange spots on the vertex and dark purplish bodies with grayish spots on the sides and long setae on the ventrolateral area. Young ***A. hasta*** larvae (I) are light green in color. They are sparsely covered with hairs and have an irregular brown and yellow dorsal band. The tubercles are pale yellow. Mature larvae (J) are about 30 mm long, are dark gray in color, and are sparsely covered with long white hairs. They have an inconspicuous middorsal row of red spots.

Damage

Acronicta americana has occasionally reached outbreak proportions elsewhere, but none of the other species have become abundant enough to have an adverse effect on their hosts.

Bibliography: 116, 139, 188, 203, 456

Figure 60. Dagger moths. A. Poplar dagger moth, *Acronicta leporina* (Linnaeus), larva. **B.** American dagger moth, *A. americana* (Harris), larva. **C.** Cottonwood dagger moth, *A. lepusculina* Guenée, larva. **D.** *A. quadrata* Grote larva. **E.** Gray dagger moth, *A. grisea* Walker, larva. **F.** Alder dagger moth, *A. dactylina* Grote, larva. **G.** Young birch dagger moth, *A. innotata* Guenée, larva. **H.** Mature *A. innotata* larva. **I.** Young cherry dagger moth, *A. hasta* Guenée, larva. **J.** Mature *A. hasta* larva.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TUSSOCK MOTHS AND THEIR ALLIES (Figure 61)

Distribution, Hosts, and Importance

Several species of insects are called tussock moths because their larvae have dense brushes of hairs resembling tussocks. Some of them are major pests, while others are of minor importance. The rusty tussock moth, ***Orgyia antiqua*** (Linnaeus), is a European species that was accidentally introduced into North America and has spread across the continent. It feeds on a wide variety of hosts, including most conifers and all hardwoods. The whitemarked tussock moth, ***O. leucostigma*** (J.E. Smith), is native to North America. Its range extends as far west as Alberta. Hosts include most hardwoods and many conifers. ***Dasychira vagans*** (Barnes & McDunnough) is a transcontinental species that feeds on trembling aspen, willow, and a variety of other hosts.

The gypsy moth, ***Lymantria dispar*** (Linnaeus), was introduced into North America in the 19th century and is gradually spreading westward. It has not yet reached the prairie provinces, but it is probably only a matter of time until it does. It will feed on almost any species of tree or shrub. The yellow woollybear, ***Spilosoma virginica*** (Fabricius), feeds on willow, trembling aspen, Manitoba maple, alder, and other hardwoods throughout the region. The spotted tussock moth, ***Lophocampa maculata*** (Harris), has a transcontinental distribution. Its hosts include willow, Manitoba maple, white birch, trembling aspen, and a variety of other hardwoods. The pale tussock moth, ***Halysidota tessellaris*** (J.E. Smith), is an eastern species whose range extends as far west as southern Manitoba. It feeds on bur oak and a variety of other hardwoods.

None of the above insects have reached outbreak levels in the prairie provinces, although ***O. antiqua*** and ***Lophocampa maculata*** are sometimes abundant. ***Lymantria dispar*** is a major pest in eastern North America and may become one in this area if it spreads westward.

Life Cycle and Appearance

All of the above insects have one generation per year in the prairie provinces. ***Orgyia antiqua*** overwinters in the egg stage. The eggs are laid in a mass, usually on the female's cocoon (C), and are not covered. Larvae emerge from the eggs in June and move onto the foliage. They are very hairy and reach a length of 25–30 mm at maturity in July or August (D). There are four dense tufts of whitish or yellowish hairs along their backs and five pencils of black hairs: two at the front, two lateral, and one dorsal at the rear. The larvae spin silken cocoons on twigs or other surfaces. Moths emerge from late July to September. Male moths (A) are brownish and have a wingspan of 25–30 mm. Female moths (B) are also brown but are wingless and are about 20 mm long. ***Orgyia leucostigma*** has a similar life cycle, but the eggs are covered with a frothy white mass. The four dorsal tufts on the larvae are pure white, and there are no lateral pencils (E). ***Dasychira vagans*** overwinters as a young larva. The dorsal tufts on the larvae are dark gray, the body hairs are whitish, and there are two pairs of black pencils, one at the front and the other at the rear (F).

Lymantria dispar overwinters in the egg stage. Adults of both sexes have wings, but only the males fly. The males have brown fore wings with darker markings, and the females have whitish fore wings marked with dark wavy lines. The larvae (G) are very hairy and reach a length of 30–65 mm when fully grown. The body is yellowish brown and densely mottled with black and has a middorsal row of blue and red tubercles. ***Spilosoma virginica*** probably overwinters in the pupal stage. Adults emerge in late spring or early summer. They have white wings, a white abdomen with orange and black bands, and a wingspan of about 30 mm. The larvae (H) have yellowish heads and bodies and are about 30 mm long when mature. Each body segment has several prominent tubercles, each bearing numerous long hairs. The dorsal hairs and tubercles are orange, and the lateral hairs are white. ***Lophocampa maculata*** overwinters in the pupal stage. The moths emerge in late June and have mottled brown and yellow fore wings. The larvae (I) are pretty, black and yellow caterpillars, commonly known as woolly bears. They reach a length of about 30 mm when fully grown. There is considerable variation in the amount of black hairs at each end of the larvae, and some individuals lack the row of black dorsal hair clumps. ***Halysidota tessellaris*** has a similar life cycle, but the body hairs on the larvae are usually silver-gray (J). There are three black pencils and several white ones at the front, two black pencils at the rear of the larvae, and a middorsal row of dark gray tufts. The larvae reach a length of about 35 mm when fully grown.

Damage

The damage caused by all of these insects is a result of defoliation. So far, none of them have been abundant enough in the prairie provinces to cause any discernable damage to their hosts, but the gypsy moth may eventually become a major pest if it becomes established in this area.

Bibliography: 132, 139, 182, 203, 217, 297, 368, 391, 456

Figure 61. Tussock moths and their allies. A. Male rusty tussock moth, *Orgyia antiqua* (Linnaeus). **B.** Adult female *O. antiqua*. **C.** *O. antiqua* egg mass. **D.** *O. antiqua* larva. **E.** Whitemarked tussock moth, *O. leucostigma* (J.E. Smith), larva. **F.** *Dasychira vagans* (Barnes & McDunnough) larva. **G.** Gypsy moth, *Lymantria dispar* (Linnaeus), larva.* **H.** Yellow woollybear, *Spilosoma virginica* (Fabricius). **I.** Spotted tussock moth, *Lophocampa maculata* (Harris), larva. **J.** Pale tussock moth, *Halysidota tessellaris* (J.E. Smith), larva.

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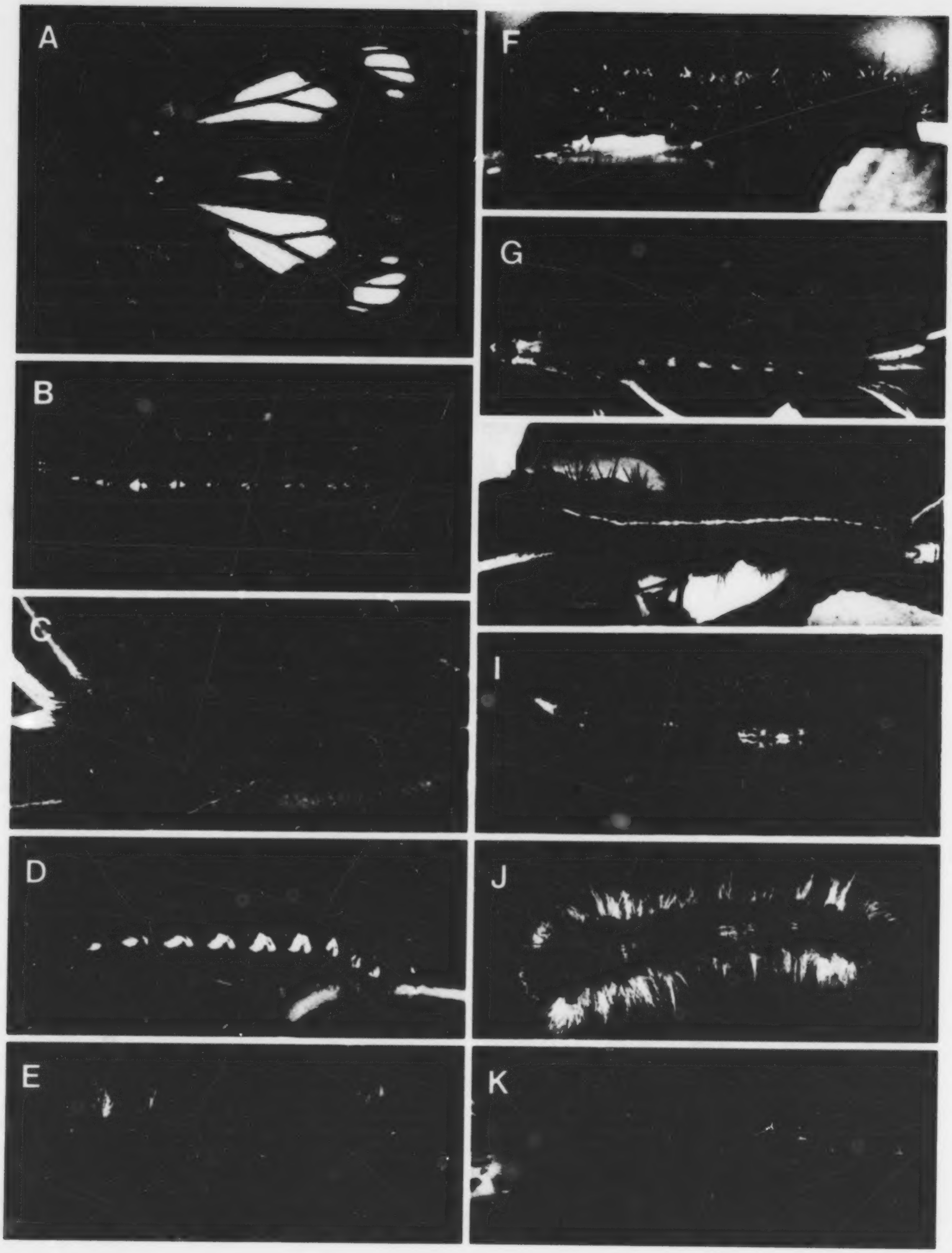
* Photograph courtesy of Great Lakes Forestry Centre.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HAIRY OR SPINY LARVAE ON HARDWOODS (Figure 62)

Distribution, Hosts, and Importance

A variety of spiny or hairy caterpillars found feeding on various hardwoods are of no economic importance. Most species are believed to occur throughout the prairie provinces.

Gnophaela latipennis (Boisduval) feeds primarily on ground vegetation but has been found on white birch in Alberta. The giant tiger moth, ***Platarctia parthenos*** (Harris), attacks willow, alder, and birch. ***Simyra henrici*** (Grote) feeds primarily on grass and other low vegetation in moist areas but is occasionally found on willow and balsam poplar. ***Spilosoma dubia*** (Walker) feeds primarily on ground cover plants but is occasionally found on dogwood, choke cherry, alder, and poplar. Lyman's haploa, ***Haploa confusa*** (Lyman), feeds on willow, poplar, and other hardwoods in Manitoba and Saskatchewan.

The great tiger moth, ***Arctia caja americana*** Harris, feeds on the May Day tree, honeysuckle, and lilac and has been locally abundant in southern Alberta. ***Apantesis virgo*** (Linnaeus) occasionally feeds on trembling aspen, saskatoon, and western snowberry but its preferred host is common bedstraw. It has been locally abundant in central Saskatchewan. ***Meganola minuscula*** (Zeller), on bur oak, and the velleda lappet moth, ***Tolype velleda*** (Stoll), on elm, ash, birch, basswood, and bur oak, are eastern species whose ranges extend into southern Manitoba. The lappet moth, ***Phyllodesma americana*** (Harris), feeds on poplar, willow, birch, and other hardwoods. It also becomes locally abundant.

Life Cycle and Appearance

Little is known about the life cycles for most of these insects, but they all probably have one generation per year. Adults of the following seven species have wingspans of 40-60 mm. The larvae are about 40 mm long when mature, and their bodies are covered with bristled tubercles. The front and hind wings of ***G. latipennis*** (A) are bluish black with white markings between the veins except for a border around the wings and a transverse band across the front wings. The larvae have reddish brown heads and black bodies with conspicuous yellow and blue markings (B). The front wings of ***P. parthenos*** are brown with yellow spots. The hind wings are deep yellow with black markings. The larvae (C) are bluish black. ***Simyra henrici*** adults are creamy-white moths with light gray-brown markings between the veins. The larvae (D) have reddish brown heads and a black upper body. There are white markings along the sides of the body, and the tubercles are red. The front and hind wings of ***Spilosoma dubia*** females are white and black. Males are smaller and have yellow hind wings spotted with black. The larvae (E) have brownish gray bodies with gray and black setae and have a continuous middorsal yellow stripe and two broken subdorsal yellow stripes. ***Haploa confusa*** adults are white moths with extensive black or brown markings and a transverse band on the front wings. The hind wings are white. The larvae (F) are blackish with short black and white setae. There are conspicuous broken dorsal and subdorsal yellow and white lines.

The front wings of ***Arctia caja americana*** are brown with white markings. The hind wings are orange and usually have four bluish black spots. The larvae (G) are black and are covered with a mixture of long black and white hairs. Some of the hairs along the sides are tawny. ***Apantesis virgo*** adults have black front wings with pale veinlike markings and have a wingspan of 40-50 mm. The body and hind wings are scarlet with black marks or dots. The dorsal half of the larvae (H) is bluish black, and the ventral half is reddish purple. A whitish middorsal line extends the length of the body, and the body hairs are reddish brown.

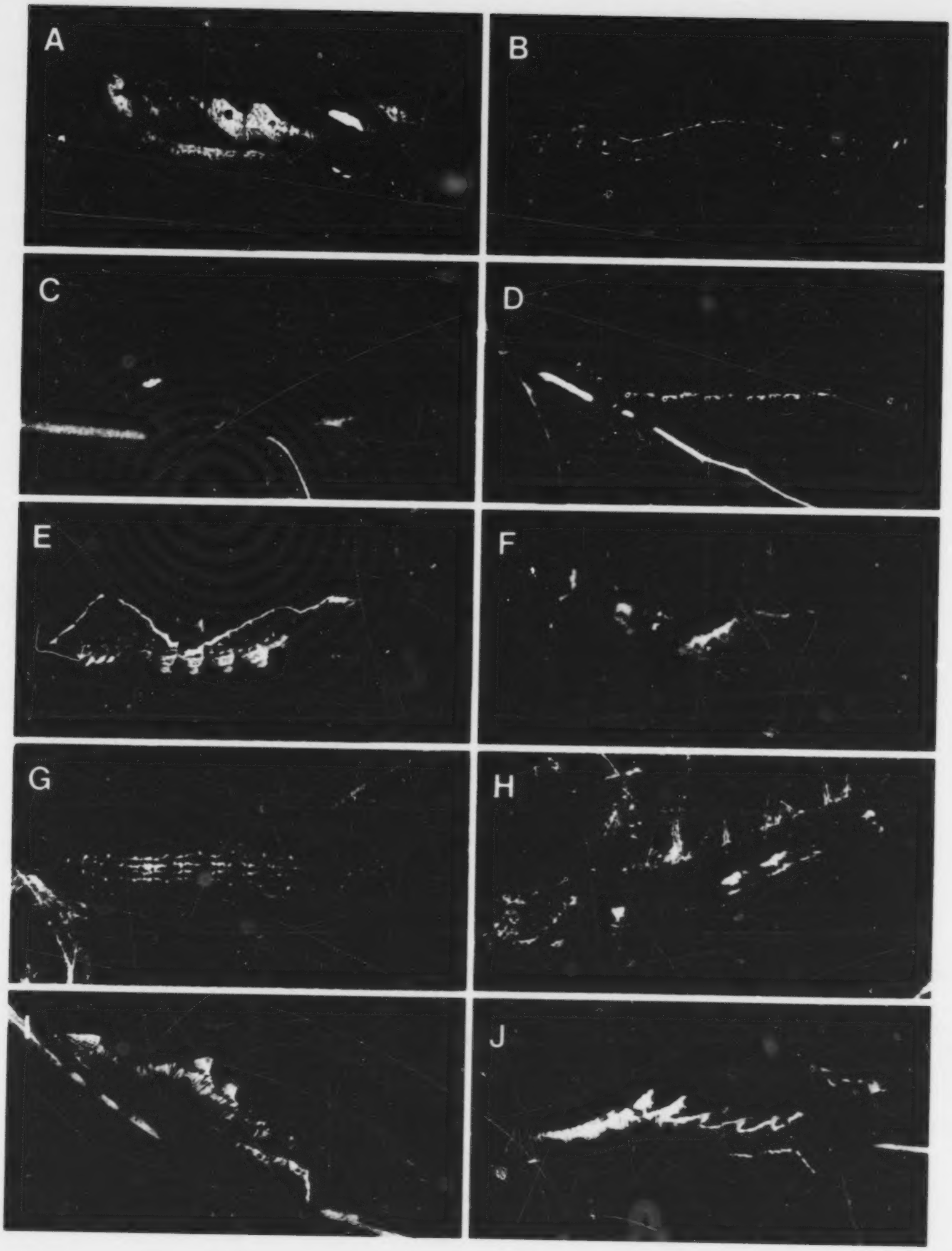
Meganola minuscula adults are powdery gray moths that have a wingspan of 17-18 mm. The larvae (I) are brownish gray with three lighter gray dorsal patches. They are about 15 mm long at maturity. Each body segment has several bristled warts. ***Tolype velleda*** adults have grayish or dusky wings marked with white lines and have a wingspan of 40-60 mm. The larvae (J) are gray and flattened and have lateral warts along each side of the body, each bearing numerous long light gray hairs. The third thoracic segment bears a pair of warts and has a velvety black band just behind the warts. The wings of ***P. americana*** are reddish brown with pale bands edged with dark brown. The edges of the wings are deeply notched, and the wingspan is 30-50 mm. The larvae (K) are variable in color, ranging from a light brownish gray to a dark mottled bluish gray. They are somewhat flattened and also have lateral warts, each of which bears several fine hairs. They are about 60 mm long when mature. The second and third thoracic segments each have a transverse scarlet band.

Damage

Defoliation caused by these insects has no adverse effect on the host trees. Even the most abundant of these species seldom cause any noticeable defoliation.

Bibliography: 139, 188, 189, 190, 391, 456, 476, 552

Figure 62. Hairy or spiny larvae on hardwoods. A. Adult *Gnophaela latipennis* (Boisduval). **B.** *G. latipennis* larva. **C.** Giant tiger moth, *Platarctia parthenos* (Harris), larva. **D.** *Simyra henrici* (Grote) larva. **E.** *Spilosoma dubia* (Walker) larva. **F.** Lyman's haploa, *Haploa confusa* (Lyman), larva. **G.** Great tiger moth, *Arctia caja americana* Harris, larva. **H.** *Apantesis virgo* (Linnaeus) larva. **I.** *Meganola minuscula* (Zeller) larva. **J.** Velleda lappet moth, *Tolype velleda* (Stoll), larva. **K.** Lappet moth, *Phyllodesma americana* (Harris), larva.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THE UNICORN CATERPILLAR AND ITS RELATIVES (Figure 63)

Distribution, Hosts, and Importance

The unicorn caterpillar, ***Schizura unicornis*** (J.E. Smith), and the redhumped caterpillar, ***S. concinna*** (J.E. Smith), are members of a large family in which the larvae of several species have fleshy humps or appendages. Both species feed on white birch, willow, trembling aspen, and a variety of other hardwoods. The humped caterpillar, ***S. leptinoides*** (Grote), feeds mainly on white birch. The false hornworm, ***Pheosa rimosa*** Packard, feeds on poplar and willow. ***Furcula occidentalis*** (Lintner) is found on willow, and ***F. modesta*** (Hudson) occurs on trembling aspen and willow. The redmarked tent maker, ***Clostera apicalis*** (Walker), feeds on willow, poplar,and white birch, and the rustylined leaftier, ***C. albosigma*** Fitch, attacks poplar, willow, and alder. ***Notodonta simplaria*** Graef and ***N. scitipennis*** Walker both feed on trembling aspen and willow.

All of the above species have a widespread distribution. They are seldom abundant, however, and none are of economic importance.

Life Cycle and Appearance

Little is known about the life histories of any of these insects. Most appear to have one or sometimes two generations per year, and they overwinter as prepupae or pupae in the duff. The adults are mostly dull-colored moths in shades of cream, brown, or gray, with a wingspan of 30–50 mm. The larvae are probably easier for the layman to recognize, although the coloration of some species is extremely variable (Fig. 64).

Schizura unicornis has a high hump on the first abdominal segment, and the thorax is green (A). The dorsal area of the abdomen has a conspicuous,white V-mark edged in dark brown. The remainder of the body is whitish or creamy brown with pink reticulations. There are small, paired dorsal tubercles on several abdominal segments. ***Schizura concinna*** has a reddish head, and the first abdominal segment is enlarged to form a hump (B). The body is dull yellow with black and white stripes. The tubercles are black and prominent. The larvae are gregarious and feed or rest in clusters. ***Schizura leptinoides*** resembles the unicorn caterpillar, but the thorax is brown with darker brown on the dorsal area (C). It also has more humps on the abdomen. The larvae of all three species are 25–30 mm long at maturity.

Pheosa rimosa larvae (D) superficially resemble hornworms (Fig. 68). The larvae are shiny, however, and the horn is fleshy. They may be green, gray, or brown or a mixture of these colors and are about 40 mm long at maturity.

Furcula occidentalis larvae have white-dotted green bodies with a yellow-edged, undulating brown dorsal band extending down their length (E). There is a pair of dorsal tubercles on the first thoracic segment, and the anal prolegs are modified into a pair of fleshy appendages. ***Furcula modesta*** larvae (F) are similar, but their bodies are yellowish green and the dorsal band is purplish brown. The thoracic tubercles are reduced to humps, and the saddle portion of the dorsal band is spotted with yellow. The larvae of ***Clostera apicalis*** and ***C. albosigma*** have pairs of dorsal tubercles on most body segments and are about 30 mm long when fully grown. *Clostera apicalis* larvae (G) are dark gray with four irregular whitish dorsal stripes. *Clostera albosigma* larvae (H) are brownish black with four discontinuous yellowish dorsal stripes.

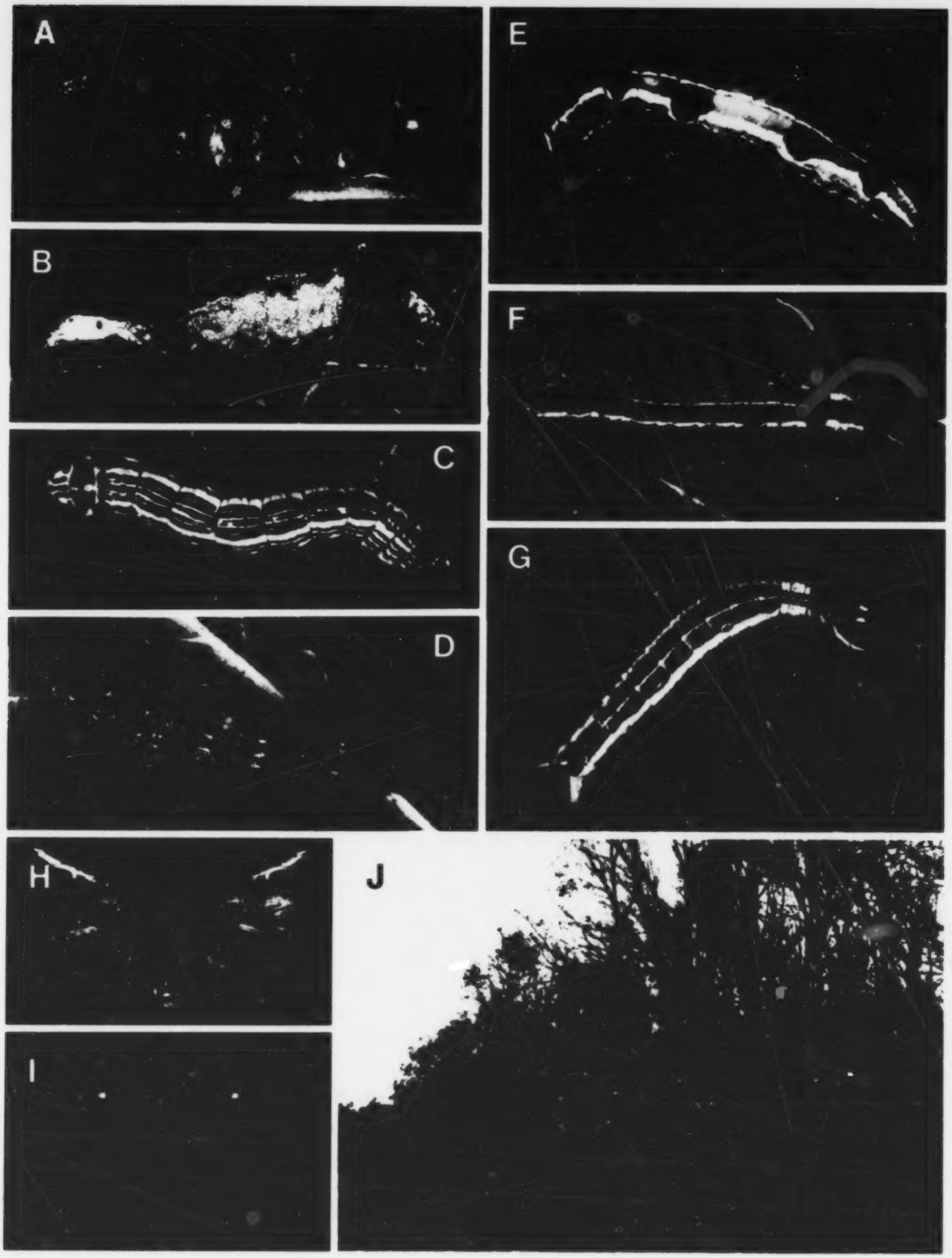
Notodonta simplaria and ***N. scitipennis*** larvae are very similar. Both have humps on the second, third, and eighth abdominal segments and hold the rear of the abdomen in an elevated position when at rest. *Notodonta simplaria* larvae (I) are a medium purplish gray ventrally and have a lateral band of the same color; the rest of the body is light purplish gray except for the rear of the abdomen, which is a mottled orange-brown. The corresponding colors for *N. scitipennis* larvae (J) are slate gray below, whitish above, and mottled yellow and dark brown at the rear. There are also several subdorsal whitish diagonal lines on a slate gray background in the middle of the abdomen.

Damage

Schizura concinna occasionally causes noticeable defoliation on scattered willow bushes. The other species have caused no noticeable damage.

Bibliography: 139, 187, 203, 456, 476

Figure 63. The unicorn caterpillar, *Schizura unicornis* (J.E. Smith), and its relatives. A. *S. unicornis* larva. **B.** Redhumped caterpillar, *S. concinna* (J.E. Smith). **C.** Humped caterpillar, *S. leptinoides* (Grote), larva. **D.** False hornworm, *Pheosa rimosa* Packard. **E.** *Furcula occidentalis* (Lintner) larva. **F.** *F. modesta* (Hudson) larva. **G.** Redmarked tent maker, *Clostera apicalis* (Walker), larva. **H.** Rustylined leaftier, *C. albosigma* Fitch, larva. **I.** *Notodonta simplaria* Graef larva. **J.** *N. scitipennis* Walker larva.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THE VARIABLE OAK LEAF CATERPILLAR AND ITS ALLIES (Figure 64)

Distribution, Hosts, and Importance

The variable oak leaf caterpillar, ***Lochmaeus manteo*** Doubleday, is one of a group of insects that occasionally causes severe defoliation of bur oak and other hardwoods in southern Manitoba. The most abundant associated species in a recent outbreak were the redhumped oakworm, ***Symmerista canicosta*** Franclemont, and the lacecapped caterpillar, ***Oligocentria lignicolor*** (Walker). A related insect, ***O. semirufescens*** (Walker), is occasionally found on alder, willow, and a variety of other hardwoods.

The pinkstriped oakworm, ***Anisota virginiensis*** (Drury), feeds on bur oak, white birch, and a variety of other hardwoods. It has also caused extensive defoliation of bur oak in southern Manitoba.

Although occasionally very abundant, none of these insects are of economic importance. Known outbreaks, although sometimes locally severe, have been of short duration and have subsided naturally after 2 or 3 years.

Life Cycle and Appearance

All of these insects have one generation per year and overwinter as prepupae or pupae in the duff. Adult ***O. semirufescens*** have a wingspan of 35–45 mm. The front wings are grayish and are shaded with dull red; the hind wings are whitish with gray shadings. The larvae (A) resemble *Schizura* larvae (Fig. 63) but can be separated from them by the small hump on the thorax, which is just ahead of the large hump on the first abdominal segment. Adult ***O. lignicolor*** have a wingspan of 40–50 mm. The narrow front wings are streaked with white, brownish gray, and reddish brown. The hind wings are white or light gray. The larvae (B) resemble *S. unicornis* (Fig. 63) but have green on the dorsal area of the abdomen. They also have a small hump on the thorax just ahead of the large hump on the first abdominal segment, and they lack the small humps on the fourth and fifth abdominal segments.

Symmerista canicosta adults (H) have a wingspan of 35–50 mm. The wings and body are various shades of ash gray. A band near the front edge of the fore wings is almost white, and there is a sharp, irregular edge butting onto a grayish brown band on the outer half of the wing. Mature larvae (C) are about 40 mm long with orange-red heads and a rounded orange hump on the eighth abdominal segment. There are five black lines down the back separated by white. The rest of the body is marked with sharply defined black, white, and yellow lines.

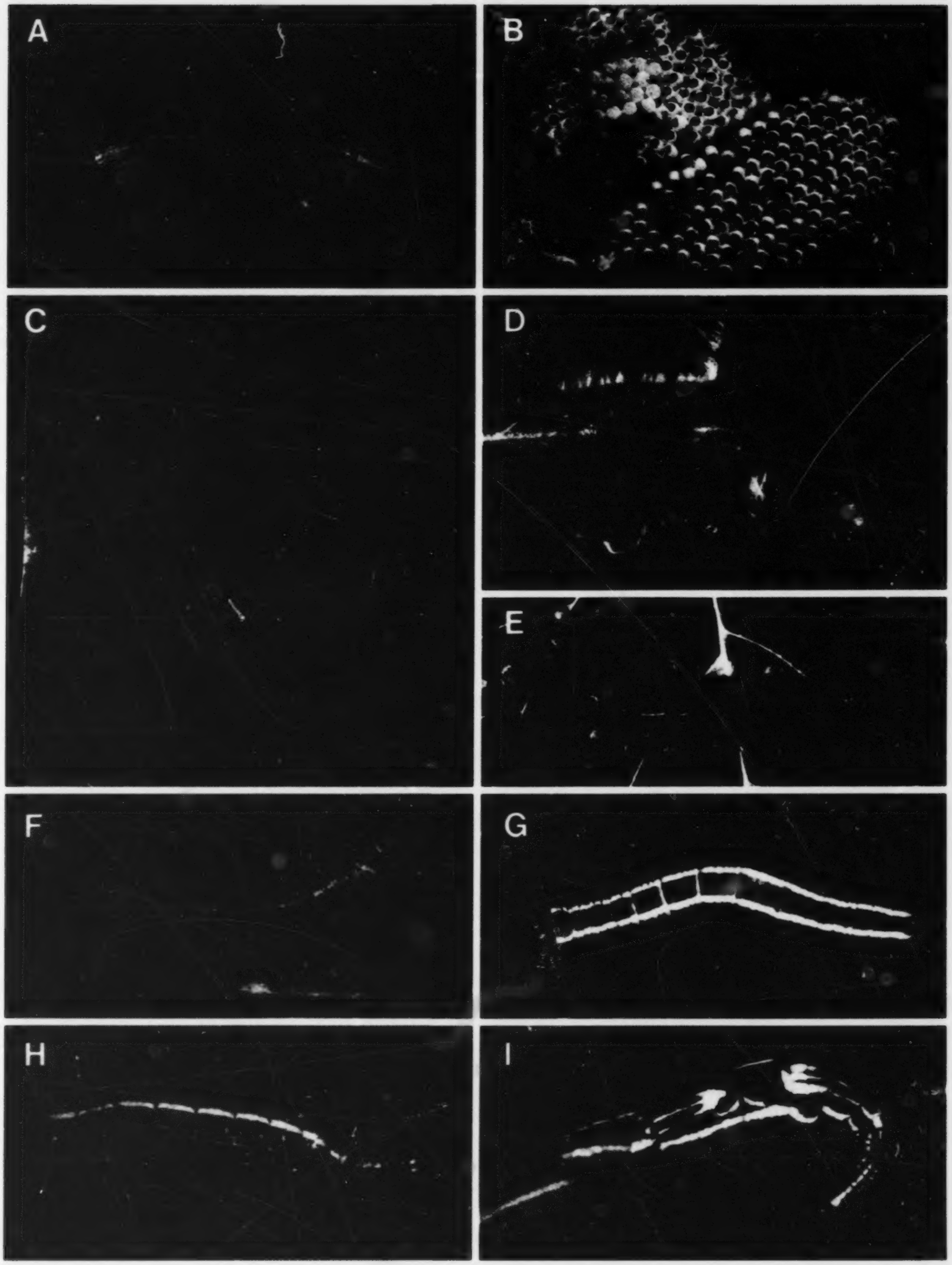
Anisota virginiensis adults (I) emerge in late June or early July. They are brownish colored moths, sometimes with a purplish cast to the outer portion of the wings. There is a white spot on each of the front wings. Females have a wingspan of about 37 mm, and the males are smaller and often have areas on their wings that are largely devoid of scales. The larvae (D) feed gregariously until nearly mature, when they reach a length of about 50 mm. They have brownish gray heads, and their bodies are marked with longitudinal dull pink and dark gray bands. The body is covered with numerous white granulations, and each segment has several short black spines. Two of these spines, just behind the head, are much longer than the rest and look like a pair of horns. ***Lochmaeus manteo*** adults emerge in June and lay eggs singly on the leaves. The moths are ash gray in color and have a wingspan of 37–42 mm. Mature larvae (E, F, G) are about 37 mm long and are yellowish green in color with white stripes and variable purplish brown markings. There is also a dark purplish brown mark down each side of the head.

Damage

The defoliation of bur oak caused by some of these insects is sometimes severe (J). Mortality of defoliated trees occasionally occurs if the infestation lasts for several years, but the insect populations usually collapse before this happens.

Bibliography: 139, 187, 203, 391, 412, 456, 476

Figure 64. The variable oak leaf caterpillar, *Lochmaeus manteo* Doubleday, and its allies. A. *Oligocentria semirufescens* (Walker) larva. **B.** Lacecapped caterpillar, *O. lignicolor* (Walker), larva. **C.** Redhumped oakworm, *Symmerista canicosta* Franclemont. **D.** Pinkstriped oakworm, *Anisota virginiensis* (Drury). **E, F, G.** Color variations of *L. manteo* larvae. **H.** Adult *S. canicosta*. **I.** Adult *A. virginiensis*. **J.** Bur oak stand defoliated by a combination of *S. canicosta*, *L. manteo*, and *O. lignicolor* larvae.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THE YELLOWNECKED CATERPILLAR AND ITS RELATIVES (Figure 65)

Distribution, Hosts, and Importance

The yellownecked caterpillar, ***Datana ministra*** (Drury), feeds on white birch, white elm, basswood, willow, bur oak, and a variety of other hardwoods. Its range extends across Canada, but it is most common in Manitoba and Ontario. The yellowlined caterpillar, ***Nadata gibbosa*** (J.E. Smith), which attacks white birch, willow, trembling aspen, and a variety of other hardwoods, and the pale green notodontid, ***Gluphisia septentrionis*** Walker, which feeds primarily on trembling aspen, both occur throughout the prairie provinces. The elm prominent, ***Lochmaeus bilineata*** (Packard), feeds only on white elm and white birch, and the saddled prominent, ***Heterocampa guttivitta*** (Walker), attacks these two hosts plus a wide variety of other hardwoods. Both are eastern species whose range extends into southeastern Manitoba.

None of these insects are of economic importance in the prairie provinces, although *H. guttivitta* has been a major forest pest in the United States.

Life Cycle and Appearance

All of the insects shown here have similar life cycles in the prairie provinces. They each have one generation annually and overwinter as pupae in the duff. *Datana ministra* is a colonial feeder, but the rest are usually solitary.

Datana ministra adults (A) emerge in June or July and have a wingspan of about 50 mm. The head and thorax are rich brown, the abdomen is buff with brown annulations, the front wings are cinnamon with darker lines, and the hind wings are light buff. Eggs (B) are laid in large clusters on the underside of the leaves. Young larvae (C) are brownish with yellow lines. They skeletonize the leaves, but older larvae (D, E) eat all but the larger veins. Larvae of all ages have the interesting habit of holding both ends of the body in an elevated position when disturbed (C, D). Mature larvae (E) are about 50 mm long and have black heads and bodies. The prothorax is yellowish orange, and the body is sparsely clothed in inconspicuous long white hairs. There are eight longitudinal yellow lines, but the lateral lines are often discontinuous (D).

Nadata gibbosa adults emerge in June and July and have a wingspan of 45-55 mm. The fore wings are straw yellow or light ochre, are sprinkled with rust, and have brown oblique lines or markings. The hind wings are lighter in color. Mature larvae (F) are about 40 mm long and are green with numerous hairless, small white tubercles. The spiracles are dark red and the anal plate is edged in yellow; the yellow may continue along the body as a lateral stripe.

Gluphisia septentrionis adults emerge in June and have a wingspan of 28-32 mm. The front wings are gray, shaded with yellow ochre, and marked with darker lines. The hind wings are lighter and uniform in color. Mature larvae (G) are about 37 mm long and are green with conspicuous subdorsal whitish yellow stripes extending the length of the body. The larvae sometimes have black lines on the side of the head and red dots or bars along the back.

Lochmaeus bilineata adults have a wingspan of 35-40 mm. The front wings are grayish with sharply defined double wavy lines. The hind wings are brownish. Mature larvae (H) are about 35 mm long. They are variable in color and cannot be reliably separated from some color variations of *Lochmaeus manteo* Doubleday (Fig. 64) except by the host tree. *Lochmaeus bilineata* is found on white elm or white birch, and *L. manteo* is usually found on oak.

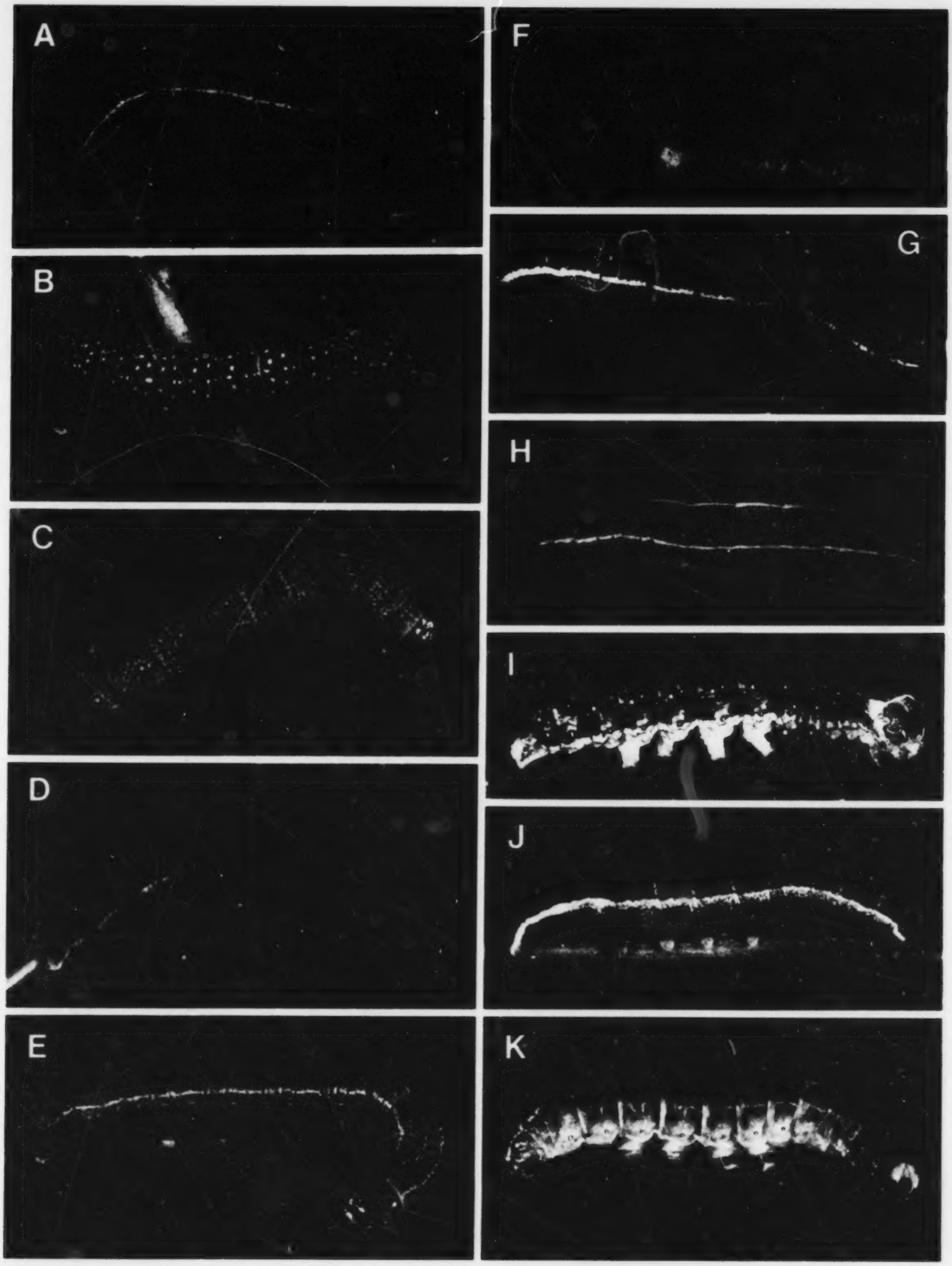
Heterocampa guttivitta adults emerge in June and have a wingspan of 40-50 mm. The moths have brownish gray or greenish gray front wings blotched with creamy-white. The hind wings are gray. The larvae (I) are variable in color and reach a length of about 35 mm when fully grown. The head is greenish with lateral purplish brown stripes. The body is green, and the back is conspicuously marked with white, gold, and purplish brown. The latter color often forms a saddle-shaped mark on the middorsal area of the abdomen.

Damage

Datana ministra is a colonial feeder and may occasionally cause noticeable defoliation of hardwoods. None of the other species are common enough to cause any damage.

Bibliography: 2, 3, 139, 187, 203, 297, 456, 476

Figure 65. The yellownecked caterpillar, *Datana ministra* (Drury), and its relatives. A. Adult *D. ministra*. **B.** Mass of *D. ministra* eggs on lower surface of a bur oak leaf. Most eggs have hatched. **C.** Group of young *D. ministra* caterpillars feeding on lower surface of a bur oak leaf. **D.** Two *D. ministra* caterpillars in alarm position. **E.** Mature *D. ministra* caterpillar. **F.** Yellowlined caterpillar, *Nadata gibbosa* (J.E. Smith), larvae. **G.** Pale green notodontid, *Gluphisia septentrionis* Walker, larva. **H.** Elm prominent, *Lochmaeus bilineata* (Packard), larva. **I.** Saddled prominent, *Heterocampa guttivitta* (Walker), larva.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THE SPECKLED GREEN FRUITWORM AND ITS ALLIES (Figure 66)

Distribution, Hosts, and Importance

The speckled green fruitworm, ***Orthosia hibisci*** (Guenée), is widely distributed in the region and feeds on poplar, willow, white birch, and a wide variety of other hardwoods and softwoods. The goldenrod cutworm, ***Cucullia intermedia*** Speyer, is often found feeding on white birch in Manitoba and Saskatchewan. ***Cosmia calami*** (Harvey), on bur oak, ***Morrisonia evicta*** (Grote), on dogwood, and ***Achatia distincta*** Hübner, on Manitoba maple, were each collected only in southern Manitoba thus far.

The herald moth, ***Scoliopteryx libatrix*** (Linnaeus), is found throughout the region, primarily on willow. ***Lithophane unimoda*** (Lintner) attacks pin cherry and choke cherry in Manitoba. ***Lithophane amanda*** (Smith) and ***L. innominata*** (Smith) have been collected at scattered locations throughout the region on alder, white birch, willow, and a variety of other hosts. ***Papestra cristifera*** (Walker) feeds on willow, alder, trembling aspen, and other hosts and is most common in western Alberta. The blackcheeked aspen caterpillar, ***Ipimorpha pleonectusa*** Grote, feeds on poplar and willow throughout the prairie provinces. None of these insects are of economic importance in this region.

Life Cycle and Appearance

All of these insects have one generation per year. *Orthosia hibisci, Cucullia intermedia, M. evicta, A. distincta,* and *P. cristifera* overwinter as pupae, and *S. libatrix* is known to overwinter as an adult. The remaining species emerge as adults during the summer or fall. Adults of most species are dull-colored gray or brownish moths with wingspans of 30–50 mm. The larvae are 30–40 mm long when fully grown.

Orthosia hibisci larvae (A) have green heads and green bodies speckled with white dots. The middorsal, subdorsal, and two lateral stripes are white. Some larvae are almost black, with white stripes, during part of the sixth instar but fade to green just before pupating. ***Cucullia intermedia*** larvae (B) in the prairie provinces have green heads and bodies with numerous white spots. There is also a black phase with yellow spots. ***Cosmia calami*** larvae (C) have pale green heads and yellowish green bodies speckled with white and resemble *O. hibisci* larvae. The white middorsal and subdorsal lines are indistinct, but the white lateral line is pronounced. ***Morrisonia evicta*** larvae (D) have brown heads and semitransparent bodies that are pinkish above and pale green below. The body is covered with small white spots, some of which form indistinct middorsal and subdorsal lines. ***Achatia distincta*** larvae (E) have pale green heads and bodies; the bodies are speckled with white. The white middorsal and paired lateral lines are indistinct, but the white subdorsal line is pronounced.

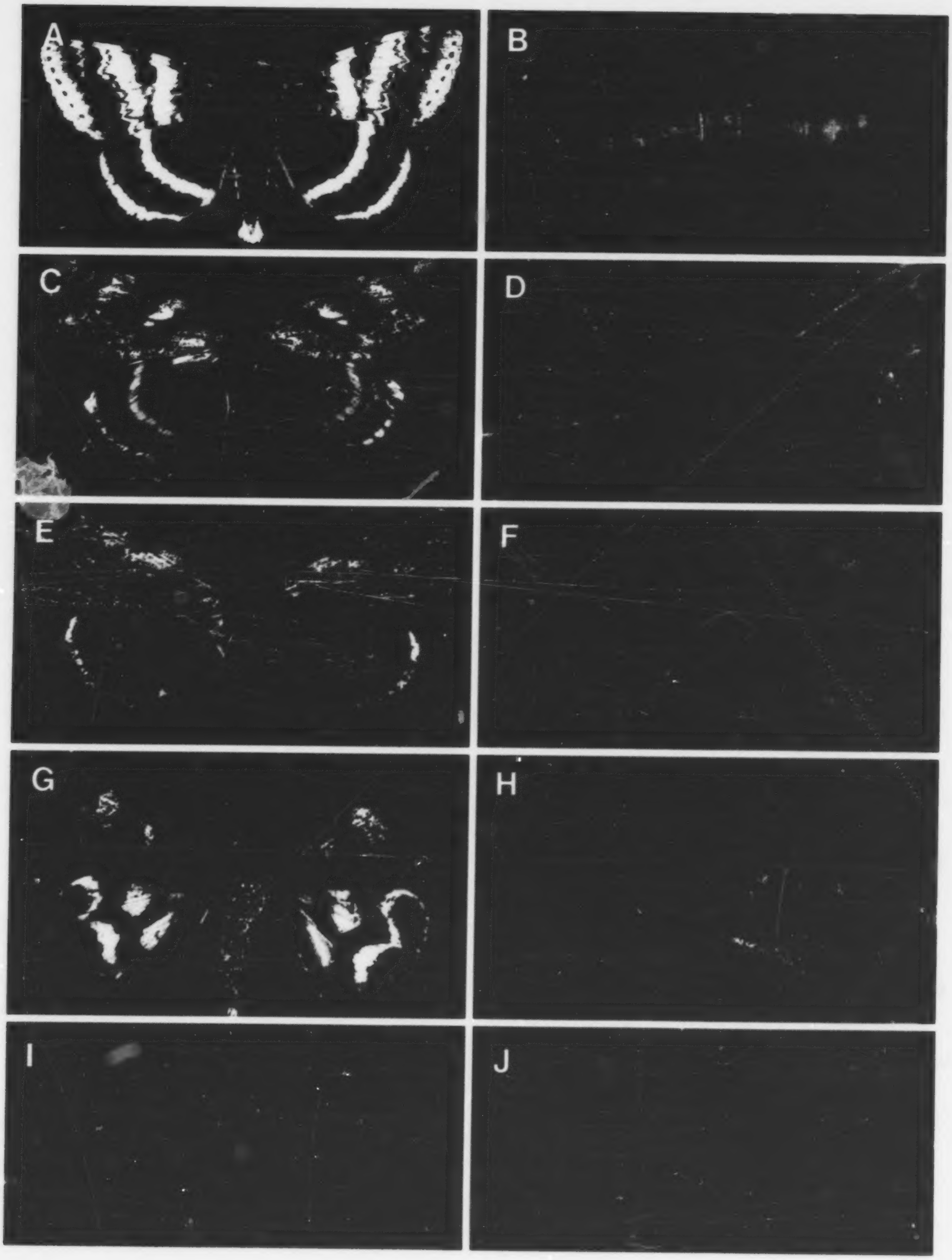
Scoliopteryx libatrix larvae (F) have green heads and bodies. The middorsal line is dark green and indistinct, and the lateral line is yellowish or whitish and is sometimes bordered below with reddish or dark green. ***Lithophane unimoda*** larvae (G) have bluish green heads and bodies. The body is covered with white spots, some of which form indistinct middorsal and subdorsal lines. The spiracles are black, and the conspicuous yellowish white lateral line extends the length of the body. ***Lithophane amanda*** larvae (H) have bluish green heads and bodies, mottled with white. The broad middorsal and lateral lines are yellowish white and the indistinct subdorsal line is white. ***Lithophane innominata*** larvae (I) have yellowish brown heads and bodies, with darker markings. The body has white spots and a dark herringbone pattern on the back of the abdomen. The spiracles are white, the middorsal and subdorsal lines are yellowish, and the lateral line is black. Young ***P. cristifera*** larvae (J) have pale green heads and green bodies flecked with white. The middorsal line is dark green, and a broad white lateral line extends the length of the body. Older larvae are gray or brown with a herringbone pattern along the back. ***Ipimorpha pleonectusa*** larvae (K) have whitish heads with a broad black band down each side of the face. The body is light green and is covered with white granulations. The broad white middorsal line extends from the second thoracic segment to the end of the abdomen. The white subdorsal and lateral lines are fine and indistinct.

Damage

None of these insects have been abundant enough in the prairie provinces to cause any damage to their hosts.

Bibliography: 116, 188, 385, 456, 476, 504

Figure 66. The speckled green fruitworm, *Orthosia hibisci* (Guenée), and its allies. A. *O. hibisci* larva. **B.** Goldenrod cutworm, *Cucullia intermedia* Speyer. **C.** *Cosmia calami* (Harvey) larva. **D.** *Morrisonia evicta* (Grote) larva. **E.** *Achatia distincta* Hübner larva. **F.** Herald moth, *Scoliopteryx libatrix* (Linnaeus), larva. **G.** *Lithophane unimoda* (Lintner) larva. **H.** *L. amanda* (Smith) larva. **I.** *L. innominata* (Smith) larva. **J.** *Papestra cristifera* (Walker) larva. **K.** Blackcheeked aspen caterpillar, *Ipimorpha pleonectusa* Grote.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UNDERWINGS AND THEIR ALLIES (Figure 67)

Distribution, Hosts, and Importance

The genus *Catocala* contains a large number of species that are known as underwings. Neither they nor their allies are of economic importance. The white underwing, ***C. relicta*** Walker, occurs throughout the region on trembling aspen and occasionally on balsam poplar and willow. The yellowbanded underwing, ***C. cerogama*** Guenée, on basswood, and ***C. coccinata*** Grote, on bur oak, occur in southern Manitoba.

Synedoida hudsonica (Grote & Robinson) feeds on buffaloberry and willow in southwestern Alberta. ***Lomanaltes eductalis*** (Walker) attacks alder and basswood in Manitoba and Saskatchewan, and ***Bomolocha palparia*** (Walker) feeds on ironwood and hazel and has been collected in Manitoba and Alberta.

Life Cycle and Appearance

All of these insects have one generation per year in the prairie provinces. The larvae are semiloopers, with at least the front pair of prolegs reduced in size, and move with a looping motion. *Catocala* species overwinter in the egg stage, and the remainder overwinter as pupae.

Catocala relicta adults (A) have white front wings banded with gray and have a wingspan of 75–80 mm. The hind wings are black, with a white edge and an inner white band. The larvae (B) have pale bodies tinged with greenish yellow and reach a length of about 50 mm when mature. The head is blackish with a pale band on the face. There is a dark band encircling most of the fifth abdominal segment, which also bears a middorsal hump. There is a pair of small middorsal tubercles on the eighth abdominal segment, just in front of a narrow dark band. The body bears a lateral fringe, and the underside of the larva is yellowish with a row of black patches. ***Catocala cerogama*** adults (C) have light gray front wings patterned with darker gray and have a wingspan of 70–80 mm. The base of the hind wing is covered with light brown hair. The remainder of the wing is black, with a white edge and a yellow band. The larvae (D) are variable in color and range from gray through dull green to brown. They are about 50 mm long when mature. The body bears numerous broken longitudinal dark lines but lacks any definite markings. There is a pair of middorsal tubercles on the eighth abdominal segment, and the underside of the body is yellowish green with brown spots. ***Catocala coccinata*** adults (E) have mottled gray front wings and a wingspan of 60–70 mm. The hind wing is scarlet, with two black bands and a white edge. The larvae (F) are mottled gray and reach a length of about 40 mm. There is a middorsal hump on the fifth abdominal segment and a pair of middorsal tubercles on the eighth abdominal segment. The underside of the body is pink with black patches.

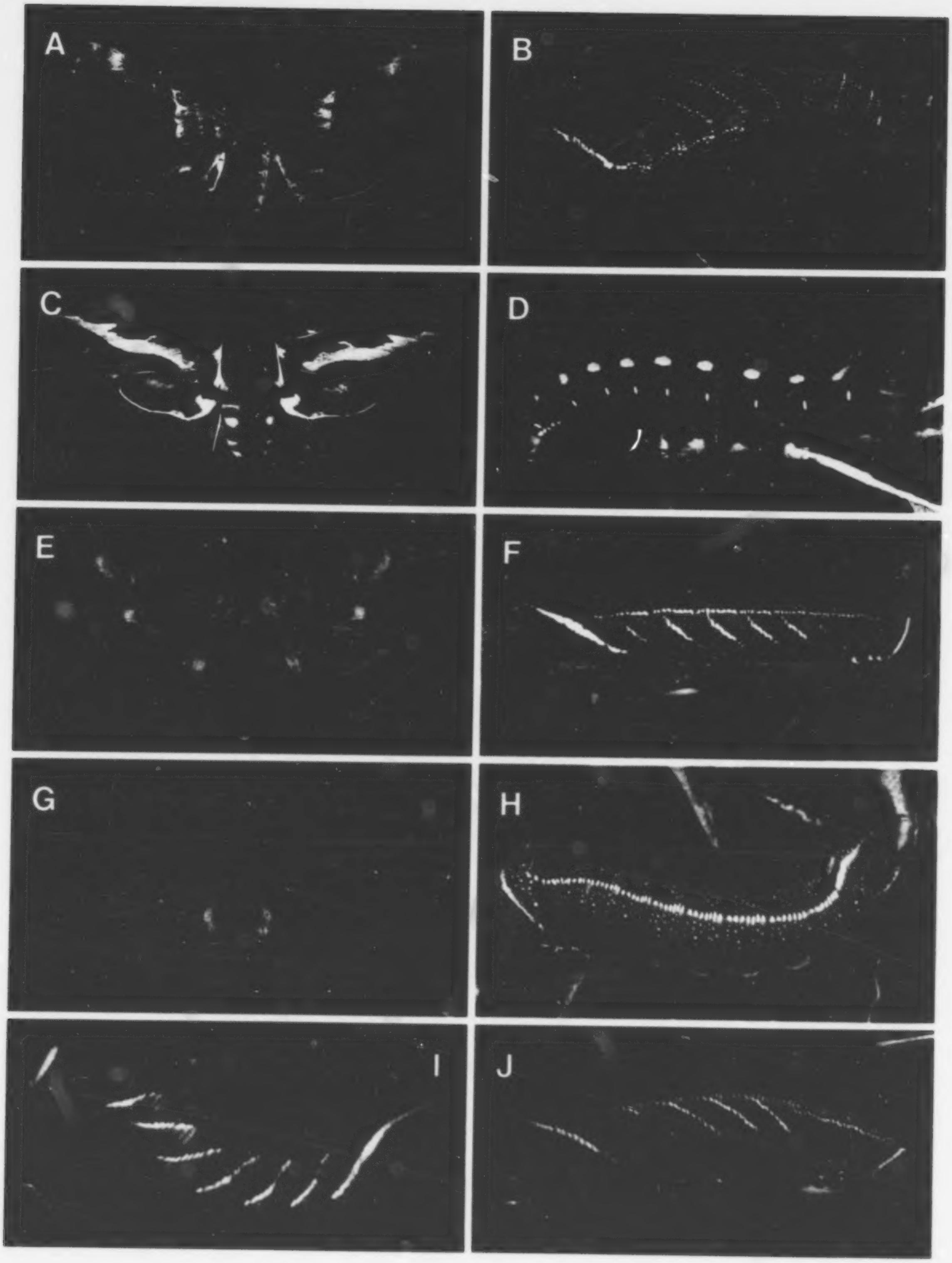
Synedoida hudsonica adults (G) have light gray front wings suffused with brown and banded with darker gray. The wingspan is about 35 mm. The hind wings are white with irregular black markings. The larvae (H) are slender with a brownish gray head and a pinkish gray body marbled with brown. They reach a length of about 35 mm when mature. ***Lomanaltes eductalis*** and ***B. palparia*** are similar in both the adult and larval stages. The moths have brownish gray front wings with dark brown lines and have a wingspan of 25–30 mm. The hind wings are pale. The larvae (I, J) are slender and green and reach a length of about 30 mm. The host will serve to separate the species.

Damage

None of these insects cause enough defoliation to damage their hosts.

Bibliography: 19, 116, 188, 456, 476, 497

Figure 67. Underwings and their allies. A. The white underwing, *Catocala relicta* Walker. **B.** *C. relicta* larva. **C.** The yellowbanded underwing, *C. cerogama* Guenée. **D.** *C. cerogama* larva. **E.** Adult *C. coccinata* Grote. **F.** *C. coccinata* larva. **G.** Adult *Synedoida hudsonica* (Grote & Robinson). **H.** *S. hudsonica* larva. **I.** *Lomanaltes eductalis* (Walker) larva. **J.** *Bomolocha palparia* (Walker) larva.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HAWKMOTHS OR HORNWORMS (Figure 68)

Distribution, Hosts, and Importance

Several genera of moths are referred to as hawkmoths or hummingbird moths because they are fast flyers and resemble hummingbirds in flight. The larvae are called hornworms because most species have a caudal horn.

The big poplar sphinx, ***Pachysphinx modesta*** (Harris), feeds on poplar and willow. The bedstraw hawkmoth, ***Hyles gallii*** (Rottemburg), usually feeds on fireweed but is occasionally found on willow. The willow sphinx, ***Smerinthus cerisyi*** Kirby, attacks poplar and willow. The twinspotted sphinx, ***S. jamaicensis*** (Drury), has a variety of hosts but is most commonly found on willow. ***Hemaris gracilis*** (Grote & Robinson) feeds on nannyberry. The great ash sphinx, ***Sphinx chersis*** (Hübner), attacks a variety of hosts but is most commonly found on ash. *Hemaris gracilis* is an eastern species whose range extends into Manitoba. The other species occur throughout the region. None are of economic importance.

Life Cycle and Appearance

The life cycles of hawkmoths have not been studied in detail. As far as is known, all species have one generation per year in the prairie provinces and overwinter as pupae. Adults emerge in the spring or early summer. They are stout-bodied moths with long narrow wings.

Pachysphinx modesta is the largest species, with an adult wingspan of 100–120 mm. The fore wings are mouse colored, usually paler on the basal third (A). The hind wings are also mouse colored and suffused with pink and have a well-developed black spot on the rear edge. The larvae change in appearance as they grow, and the caudal horn becomes relatively smaller with each molt. Mid-instar larvae (B) are pale green with white granulations. There are several diagonal stripes that sometimes have pink subdorsal dots on their leading edges. The spiracles are edged in pink, and the thoracic legs and face are also pink. Most of this pink disappears as the larvae mature, when they are about 75 mm in length.

Hyles gallii adults (C) have a wingspan of about 60 mm. The fore wings are black with a prominent white stripe. The rear edge of the wing is gray. The leading edge of the hind wing is also black. The remainder of the wing is variably marked with pink, gray, and black. The larvae (D) are extremely variable in color and may be reddish brown, greenish, or black. There is a conspicuous row of pinkish subdorsal spots along the body, and the spiracles are pale yellow. Mature larvae are about 60 mm long.

Smerinthus cerisyi adults (E) are variable in color and shape and have a wingspan of 60–85 mm. Local specimens have gray scalloped fore wings mottled with brown. The hind wings are buff and gray and suffused with pink and have a black and blue eye spot. The larvae (F) are green with white granulations, a white subdorsal stripe, and six diagonal white lines. ***Smerinthus jamaicensis*** adults (not shown) resemble those of *S. cerisyi*, but the blue spot on the hind wing is bisected by a black line. The larvae (J) are also similar, but the subdorsal white line occurs on the thorax only, and the diagonal white stripes have subdorsal red spots on their leading edges.

Hemaris gracilis adults (G) have a wingspan of about 40 mm and resemble heavy-bodied clearwing moths. The larvae (H) are apple green with white granulations and have a subdorsal row of white spots extending from the caudal horn to the prothorax, which has a yellowish anterior margin. Mature larvae are about 40 mm long.

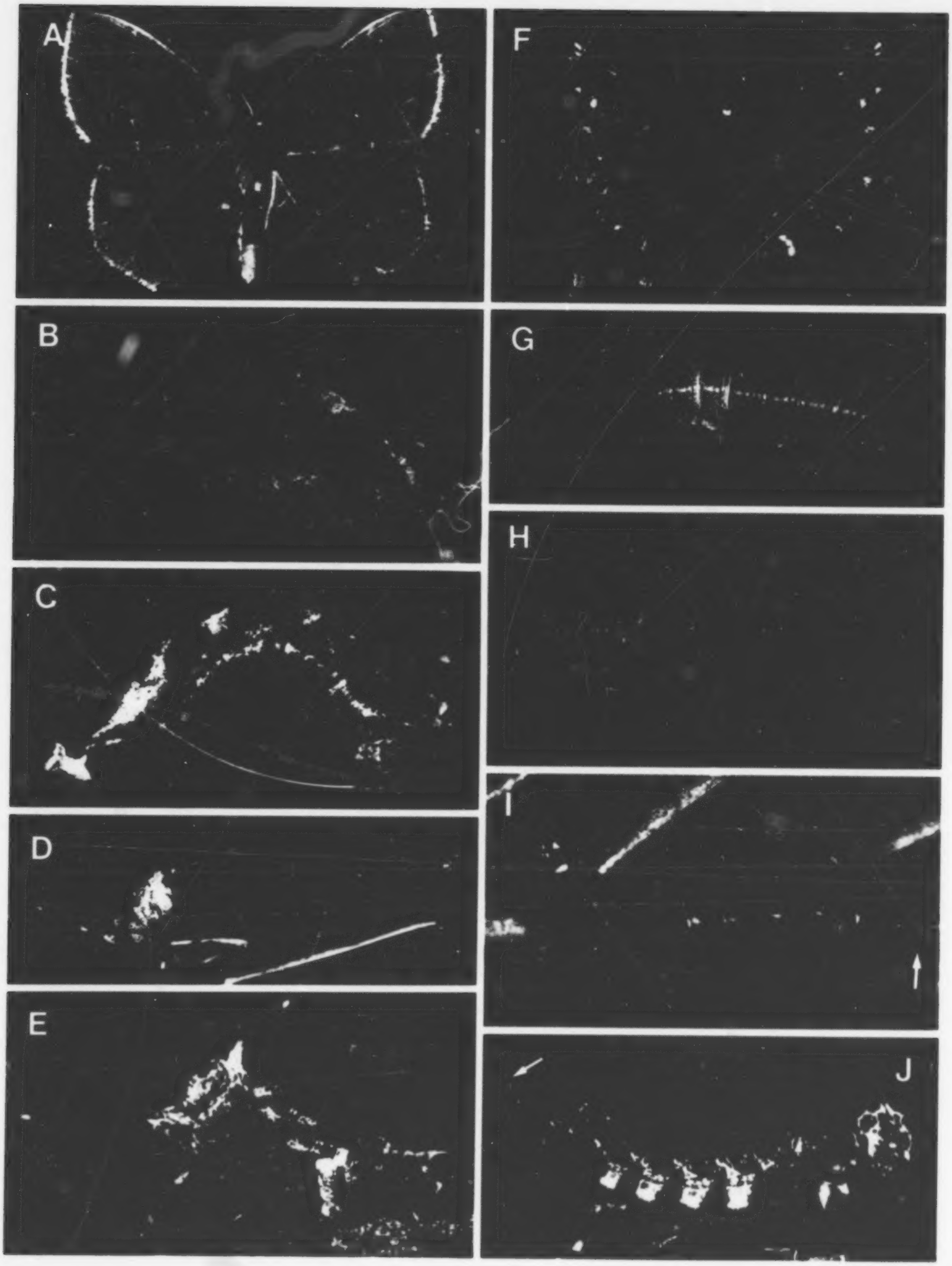
Sphinx chersis adults (not shown) have a wingspan of about 110 mm. The fore wings are dark gray, traversed by two lighter gray bands. The larvae (I) are apple green dorsally and bluish ventrally and have seven diagonal white stripes edged above with bluish green. The head is bluish with lateral white bands meeting at the apex, and the spiracles are edged in red. The larvae are smooth and reach a length of about 75 mm at maturity.

Damage

Hemaris gracilis has caused noticeable defoliation of nannyberry in ornamental plantings. ***Sphinx chersis*** occasionally defoliates ash suckers. Neither species causes any permanent damage, however, and the other species are too rare to cause noticeable defoliation.

Bibliography: 139, 187, 203, 266, 391, 476

Figure 68. Hawkmoths or hornworms. A. Big poplar sphinx, *Pachysphinx modesta* (Harris). **B.** *P. modesta* larva. **C.** Bedstraw hawkmoth, *Hyles gallii* (Rottemburg). **D.** *H. gallii* larva. **E.** Willow sphinx, *Smerinthus cerisyi* Kirby. **F.** *S. cerisyi* larva. **G.** Adult *Hemaris gracilis* (Grote & Robinson). **H.** *H. gracilis* larva. **I.** Great ash sphinx, *Sphinx chersis* (Hübner), larva. **J.** Twinspotted sphinx, *S. jamaicensis* (Drury), larva.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THE FLANGED LOOPER AND OTHER UNUSUAL LARVAE (Figure 69)

Distribution, Hosts, and Importance

The flanged looper, ***Nemoria mimosaria*** (Guenée), attacks white birch, white elm, bur oak, and willow, plus other hardwood and softwood hosts. Its range extends west to eastern Saskatchewan. ***Synchlora aerata albolineata*** Packard was collected on bur oak in southern Manitoba. ***Selenia kentaria*** (Grote & Robinson) feeds on white elm and trembling aspen and probably occurs throughout the region. The filament bearer, ***Nematocampa limbata*** (Haworth), feeds primarily on softwoods (Fig. 9) but also attacks willow, white birch, white elm, and other hardwoods in the prairie provinces.

The Juvenal dusky wing, ***Erynnis juvenalis*** (Fabricius), was collected on bur oak in southern Manitoba, and the dreamy dusky wing, ***E. icelus*** (Scudder & Burgess), is found throughout the region on willow, trembling aspen, and balsam poplar. ***Eudeilinia herminiata*** (Guenée) was collected on dogwood in central Alberta. The warty birch caterpillar, ***Drepana bilineata*** (Packard), on birch, alder, and trembling aspen, and the masked birch caterpillar, ***D. arcuata*** Walker, on birch and alder, both occur throughout the region.

None of these insects are of economic importance in the prairie provinces.

Life Cycle and Appearance

All of these insects have one generation per year and overwinter in the pupal stage. They are solitary feeders and are grouped together because of their unusual appearance in the larval stage.

Nemoria mimosaria adults (A) have green wings with two transverse white lines and a wingspan of 20–25 mm. The larvae (B) have grayish brown or reddish brown heads and bodies; the latter is marbled with lighter and darker shades. The head and body are rough in appearance, but the most unusual features are the forward-facing lateral lobes on each abdominal segment. Paired dorsal tubercles are most prominent on the second thoracic and eighth abdominal segments. ***Synchlora aerata albolineata*** adults are similar to those of *N. mimosaria*. The larvae (C) are also very similar, but the forward-facing lobes are subdorsal rather than lateral.

Selenia kentaria have yellowish brown wings marked with brown and have a wingspan of about 45 mm. The larvae (D) are a mottled brownish gray and reach a length of about 40 mm. The head is flattened, and the body is slender in front and stout at the rear. The larva at rest looks much like a dead twig. ***Nematocampa limbata*** adults are yellowish with brown marks and have a wingspan of 20–25 mm. The larvae (E) are mottled gray and brown and reach a length of about 25 mm. There are dorsal tubercles on the first and eighth abdominal segments, but the most striking feature is the pair of white-tipped dorsal filaments on the second and third abdominal segments.

Erynnis juvenalis adults (F) have a wingspan of about 40 mm. The front wings are a mottled brownish gray with black and white marks, and the hind wings are brownish gray with lighter patches. Sleeping adults reportedly fold their wings and antennae over their bodies and therefore resemble cutworm adults, but their clubbed antennae indicate that they are butterflies. The larvae (G) reach a length of about 30 mm and have large brownish heads with orange spots. Their bodies are greenish with a yellowish subdorsal line and are covered with small white spots. ***Erynnis icelus*** larvae (H) are very similar, but their heads lack the orange spots and may be brown or almost black. The middorsal line is bluish green and the subdorsal line is white.

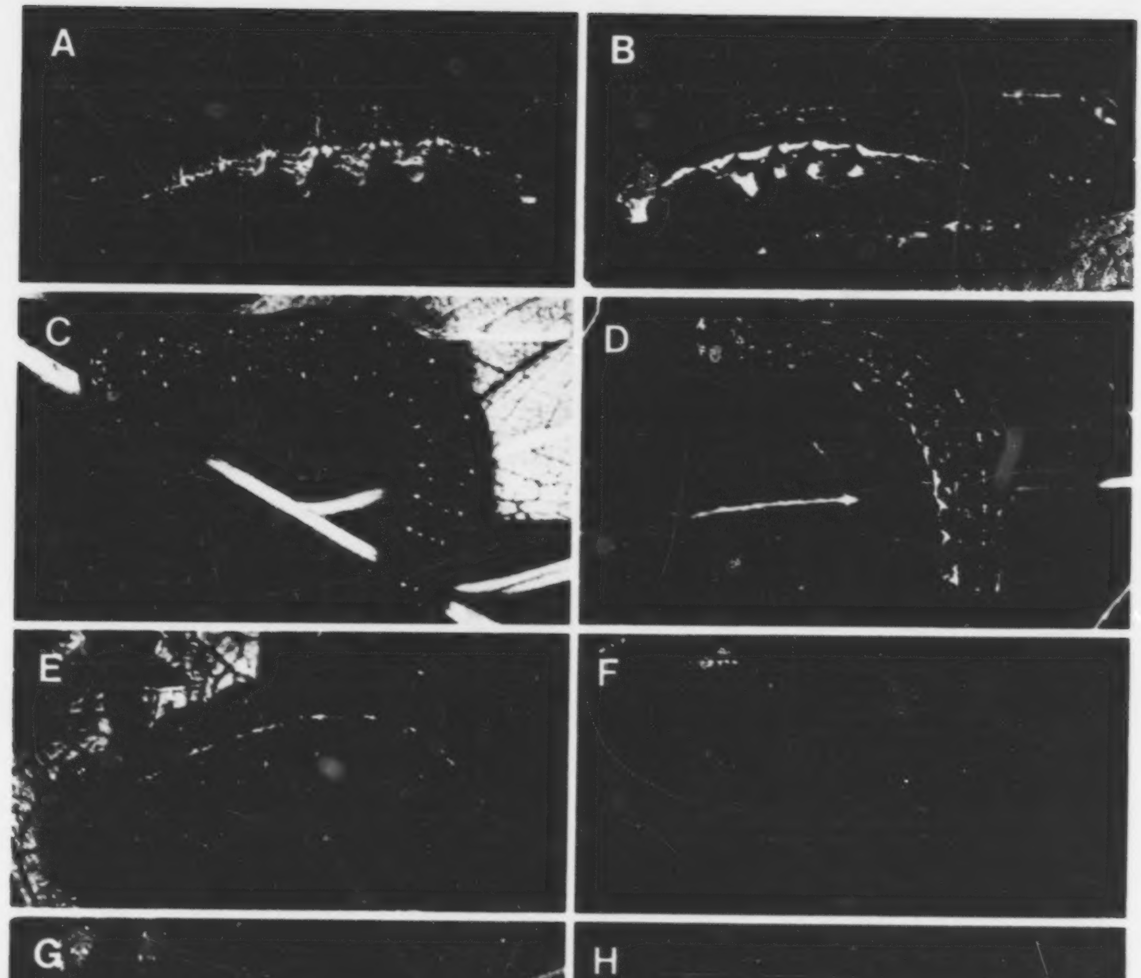
Eudeilinia herminiata adults have translucent white wings and have a wingspan of about 30 mm. The larvae (I) have yellowish green heads with brown marks on the apex. The body is pale green with an indistinct green middorsal line and black marks on the first thoracic segment. There are no anal prolegs, and the anal plate terminates in a small pink tubercle. ***Drepana bilineata*** adults have cream-colored wings with wavy brown lines and have a wingspan of about 30 mm. The larvae (J) have whitish heads with brown marbled markings. They reach a length of about 20 mm. The body is mottled brown and black and has numerous bristled tubercles. The anal prolegs are missing, and the anal plate bears a small pink tubercle. ***Drepana arcuata*** larvae resemble those of *D. bilineata* but have two dark bars across the face.

Damage

These larvae have never been abundant enough to damage their hosts.

Bibliography: 186, 187, 189, 391, 457, 476

Figure 69. The flanged looper, *Nemoria mimosaria* (Guenée), and other unusual larvae. A. Adult *N. mimosaria*. **B.** *N. mimosaria* larva. **C.** *Synchlora aerata albolineata* Packard larva. **D.** *Selenia kentaria* (Grote & Robinson) larva. **E.** Filament bearer, *Nematocampa limbata* (Haworth), larva. **F.** Adult Juvenal dusky wing, *Erynnis juvenalis* (Fabricius). **G.** *E. juvenalis* larva. **H.** Dreamy dusky wing, *E. icelus* (Scudder & Burgess), larva. **I.** *Eudeilinia herminiata* (Guenée) larva. Note pink tubercle at arrow. **J.** Warty birch caterpillar, *Drepana bilineata* (Packard). Note pink tubercle at arrow.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THE GOAT SALLOW AND ITS ALLIES (Figure 70)

Distribution, Hosts, and Importance

The goat sallow, ***Homoglaea hircina*** Morrison, feeds primarily on trembling aspen but is occasionally found on white birch, willow, and other hardwoods. ***Eupsilia tristigmata*** (Grote) attacks willow, poplar, white birch, and a wide variety of other hardwoods. ***Xylotype acadia*** (Barnes & Benjamin) defoliates alder and willow in Alberta. The grieving woodling, ***Egira dolosa*** (Grote), attacks poplar, willow, and white birch. ***Brachylomia populi*** (Strecker) feeds on balsam poplar and trembling aspen.

Pseudothyatira cymatophoroides (Guenée) feeds primarily on birch and alder and probably occurs throughout the region, but so far it has been collected only in southeastern Manitoba and western Alberta. ***Euxoa obeliscoides*** (Guenée) was collected on trembling aspen in western Alberta. The rearhumped caterpillar, ***Amphipyra pyramidoides*** Guenée, is found in southern Manitoba on basswood, white elm, bur oak, and a wide variety of other hardwoods. The yellowmarked caterpillar, ***Raphia frater*** Grote, feeds primarily on poplar and willow.

All of these insects occur throughout the region unless otherwise noted, but none are of economic importance.

Life Cycle and Appearance

These insects are all believed to have one generation per year, but their life cycles are not generally well known. *Homoglaea hircina* and *E. tristigmata* overwinter as adults, *X. acadia* and *E. dolosa* as pupae, and some of the *Euxoa* group as young larvae. The adults are mostly dull-colored moths with wingspans of 30–40 mm, but *A. pyramidoides* has a wingspan of 40–50 mm. The larvae are 30–35 mm long at maturity.

Mature ***H. hircina*** larvae (A) have brown heads and a blackish thoracic shield. The body is light brownish gray with darker brown reticulations. ***Eupsilia tristigmata*** larvae (B) have light brown heads and dark brown bodies. The whitish middorsal and subdorsal lines are indistinct, but the lateral line is well defined, particularly on the abdomen. ***Xylotype acadia*** larvae (C) have reddish brown heads with darker markings and have heavily marked gray bodies. The thoracic shield is almost black and has numerous small white spots. The subdorsal line is represented by a series of white spots, each paired with a smaller white spot, and both are enclosed in black patches. ***Egira dolosa*** larvae (D) have light brown heads with black reticulations and have gray bodies heavily marked with black. The white middorsal and subdorsal lines are indistinct, and the white lateral stripe has black markings. ***Brachylomia populi*** larvae web leaves together and have dark (E) and light (F) color phases. The dark phase is so heavily marked that it appears to be almost black. The white middorsal line is more or less continuous, but the subdorsal line is represented only by a series of irregular white dots. The light phase has a brown head and a mottled brownish gray body. The middorsal and subdorsal lines are whitish.

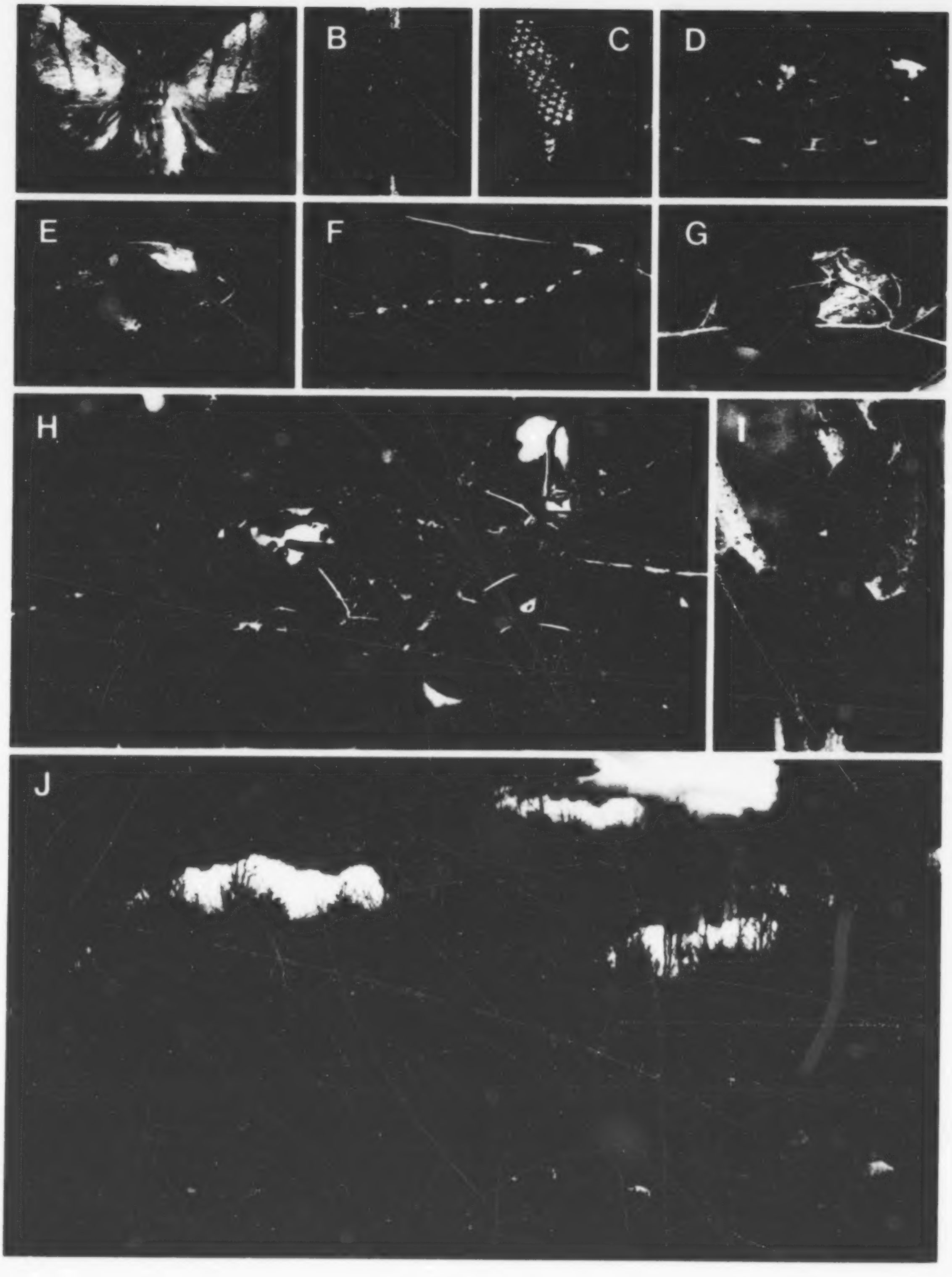
Pseudothyatira cymatophoroides larvae (G) are light brown above, changing gradually to yellowish below. The fine middorsal line is dark brown, and the subdorsal line is represented by a series of indistinct dark brown diagonal dashes, sometimes accompanied by one or more lateral white spots. ***Euxoa obeliscoides*** larvae (H) are typical cutworms and would be impossible to separate from garden cutworms if they were not feeding on trees. The head is light gray with black markings. The body is light brownish gray and is darker on the sides. The middorsal and paired subdorsal lines are whitish. Each body segment has several small, dark tubercles. ***Amphipyra pyramidoides*** larvae (I) have whitish green heads and bodies. The body has a conspicuous hump on the eighth abdominal segment and is sparsely covered with white spots. The middorsal and subdorsal lines are white, and the lateral line is yellowish. ***Raphia frater*** larvae (J) have pale green heads and pale green translucent bodies sparsely covered with yellowish white spots. There is a pair of yellowish, red-tipped, dorsal tubercles on the second thoracic segment and yellowish curved ridges, usually tipped with red, on the first, fifth, and eighth abdominal segments.

Damage

None of these insects cause enough defoliation to damage their hosts, but the feeding damage of ***B. populi*** is sometimes unsightly.

Bibliography: 116, 186, 188, 456, 457, 476, 504

Figure 70. The goat sallow, *Homoglaea hircina* Morrison, and its allies. A. *H. hircina* larva. **B.** *Eupsilia tristigmata* (Grote) larva. **C.** *Xylotype acadia* (Barnes & Benjamin) larva. **D.** Grieving woodling, *Egira dolosa* (Grote), larva. **E.** *Brachylomia populi* (Strecker) larva (dark phase). **F.** *B. populi* larva (light phase). **G.** *Pseudothyatira cymatophoroides* (Guenée) larva. **H.** *Euxoa obeliscoides* (Guenée) larva. **I.** Rearhumped caterpillar, *Amphipyra pyramidoides* Guenée. **J.** Yellowmarked caterpillar, *Raphia frater* Grote.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THE FOREST TENT CATERPILLAR (Figure 71)

Distribution, Hosts, and Importance

The forest tent caterpillar, ***Malacosoma disstria*** Hübner, is the most serious defoliator of trembling aspen. It also attacks a variety of deciduous trees such as bur oak, green ash, white birch, white elm, Manitoba maple, basswood, balsam poplar, and plains cottonwood. Outbreaks typically last 4 or 5 years, but some persist for several more years. The average period between the 1st years of severe defoliation at any given location is about 10 years, with a range of 6–16 years. This means that there is nearly always an outbreak in progress somewhere within the region.

Life Cycle and Appearance

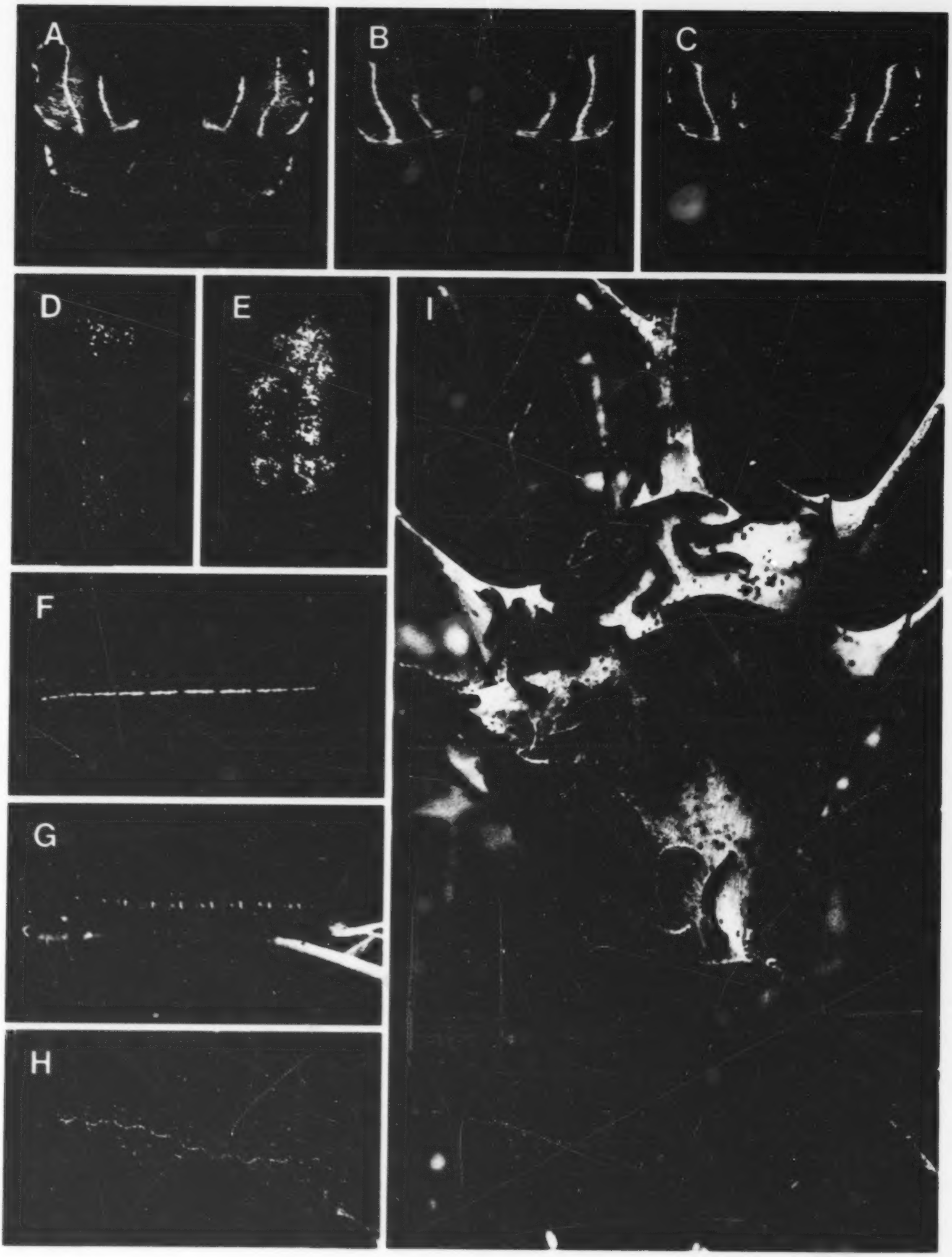
Malacosoma disstria has one generation per year. The young larvae hatch early in the spring, usually more or less coincident with the flushing of the aspen foliage. They are black and hairy (D) and are about 3 mm long. If the foliage has not flushed the larvae will mine the buds (E). The larvae are gregarious (H), and although they do not form a tent they spin a trail of silk wherever they go. When not feeding they rest in a mass on a silken mat spun on the trunk or larger branches (I). There are five larval instars. Mature larvae are about 45–55 mm long and are covered with conspicuous silky hairs. They have broad, bluish lateral bands on the body and a dorsal band that has conspicuous white or creamy keyhole-shaped markings on a predominantly brownish black background. There are broken orange and brown lateral lines on each edge of the dorsal band (F). Five or 6 weeks after hatching from the egg, the mature larvae form silken cocoons that contain a powdery yellow substance. The cocoons are spun between aspen leaves if the stand is not completely defoliated (G) but may be spun in almost any available site if the trees are stripped of foliage. The larvae pupate soon after cocoons are spun, and the stout-bodied moths (A) emerge about 10 days later. The moths live only a few days and are light yellow to buff brown in color with two oblique dark bands on the fore wings. They have a wingspan of 35–45 mm. The female deposits her eggs around a small twig in a band that usually contains between 150 and 200 eggs. The number may be as small as 100 or as great as 300, however, depending on the vigor of the female. The eggs are covered with a frothy substance called spumaline, which is silvery colored when the eggs are laid but soon becomes dark brown in color (B). Weak females often deposit egg bands that are only partially covered with spumaline (C). The embryos become fully developed larvae about a month after the eggs are laid, but the larvae do not normally emerge until the following spring.

Damage

The injury caused by ***M. disstria*** is due to the defoliation by the larvae. Light defoliation has little effect on tree growth. Two or more years of moderate-to-severe defoliation, however, causes a severe reduction in radial growth and may cause considerable branch and twig mortality. Normally, there is very little tree mortality directly attributable to defoliation, even when the trees are completely stripped of foliage (J), because the trees refoliate and produce enough new leaves to carry on essential photosynthesis. Except for increment loss, the insects cause little lasting damage, but many people find the wandering masses of larvae to be extremely objectionable.

Bibliography: 24, 102, 148, 190, 259, 262, 269, 290, 292, 324, 517, 550, 628, 629, 630

Figure 71. The forest tent caterpillar, *Malacosoma disstria* Hübner. A. Adult *M. disstria.* **B.** Egg mass covered with spumaline. **C.** Egg mass only partially covered with spumaline. **D.** Newly hatched larvae. **E.** Bud mined by feeding larvae. **F.** Mature larva. **G.** Cocoon spun in aspen leaves. **H.** Colony of feeding larvae. **I.** Larvae resting on aspen trunk. **J.** Severely defoliated aspen stand.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TENT CATERPILLARS (Figure 72)

Distribution, Hosts, and Importance

In addition to the forest tent caterpillar, three other species of tent caterpillars occur in the prairie provinces. The prairie tent caterpillar, ***Malacosoma californicum lutescens*** (Neumoegen & Dyar), usually is the most common species. Its principal host is choke cherry, but other hardwood species are also attacked. The northern tent caterpillar, ***M. californicum pluviale*** (Dyar), formerly known as the western tent caterpillar, occurs throughout the prairie provinces. The larvae feed on pin cherry, willow, choke cherry, and a wide variety of other hardwood trees and shrubs. The eastern tent caterpillar, ***Malacosoma americanum*** (Fabricius), is primarily an eastern species that occasionally is found in southern Manitoba and Saskatchewan. Its principal hosts are pin cherry and choke cherry, although other hardwood species are occasionally attacked. None of these tent caterpillars are of economic importance in this region, although ***M. californicum lutescens*** is a potential pest on ornamental plantings of Schubert choke cherry.

Life Cycle and Appearance

The life cycles of all three of these tent caterpillars are very similar. They all have one generation per year and overwinter as fully developed embryos within the eggs. The adults of ***M. americanum, M. californicum lutescens,*** and ***M. californicum pluviale*** (A, B, and C, respectively) are so similar that only an expert can separate them. The adults are stout-bodied moths and are chocolate brown to dark buff in color. They have a wingspan of 30–40 mm. All have two oblique whitish bands across the front wings, and the hind wings are uniform in color and sometimes have whitish markings. Although the adults are similar, their egg-laying habits differ. ***Malacosoma americanum*** lays its eggs in masses encircling small twigs, covering them with a frothy substance called spumaline. The egg masses (D) resemble those of *M. disstria* (Fig. 71) but have more-rounded ends. The egg masses of ***M. californicum lutescens*** (E) and ***M. californicum pluviale*** are very similar to each other. They are also covered with spumaline but do not encircle the stem and are deposited on the base of the hosts, usually within 30 cm of the ground.

The eggs of all three species hatch in the spring, more or less coincident with the flushing of foliage on their hosts, and the larvae soon begin the construction of silken nests near a fork in the stem. They forage out from these nests in search of foliage, spinning a thread of silk wherever they go, but return to the nests to rest or during periods of inclement weather. New nests may be constructed if the colonies exhaust their food supply on the original hosts. The larvae feed for 6–8 weeks, depending upon weather conditions, and are about 50 mm long when fully grown. The larvae are probably the easiest stage to identify. The larvae of all three species are sparsely hairy. Those of ***M. americanum*** (F) are black and have a whitish middorsal stripe, narrow broken orange-colored subdorsal stripes, and lateral white and blue markings. ***Malacosoma californicum lutescens*** larvae (G, I) also have black backs with a whitish middorsal stripe, but the sides of the body are a light powder blue. Young ***M. californicum pluviale*** larvae are mostly black, but the background color on older larvae (H) is not conspicuous because of the prominent markings. The white middorsal stripe is broken, and the broad subdorsal orange bands enclose bluish white and black markings. When feeding is completed all species spin multilayered yellowish white cocoons containing a powdery substance. The moths emerge about 3 weeks later.

Damage

None of these tent caterpillars are major pests in the prairie provinces, although the nests are unsightly. Ornamental plantings of Schubert choke cherry may be temporarily disfigured, but little permanent damage is likely to be caused.

Bibliography: 89, 139, 184, 190, 297, 450, 476, 550, 629

Figure 72. Tent caterpillars. A. Adult eastern tent caterpillar, *Malacosoma americanum* (Fabricius). **B.** Adult prairie tent caterpillar, *M. californicum lutescens* (Neumoegen & Dyar). **C.** Adult northern tent caterpillar, *M. californicum pluviale* (Dyar). **D.** *M. americanum* egg mass*. **E.** *M. californicum lutescens* egg mass. **F.** *M. americanum* larva*. **G.** *M. californicum lutescens* larva. **H.** *M. californicum pluviale* larva. **I.** *M. californicum lutescens* larvae resting on nest.

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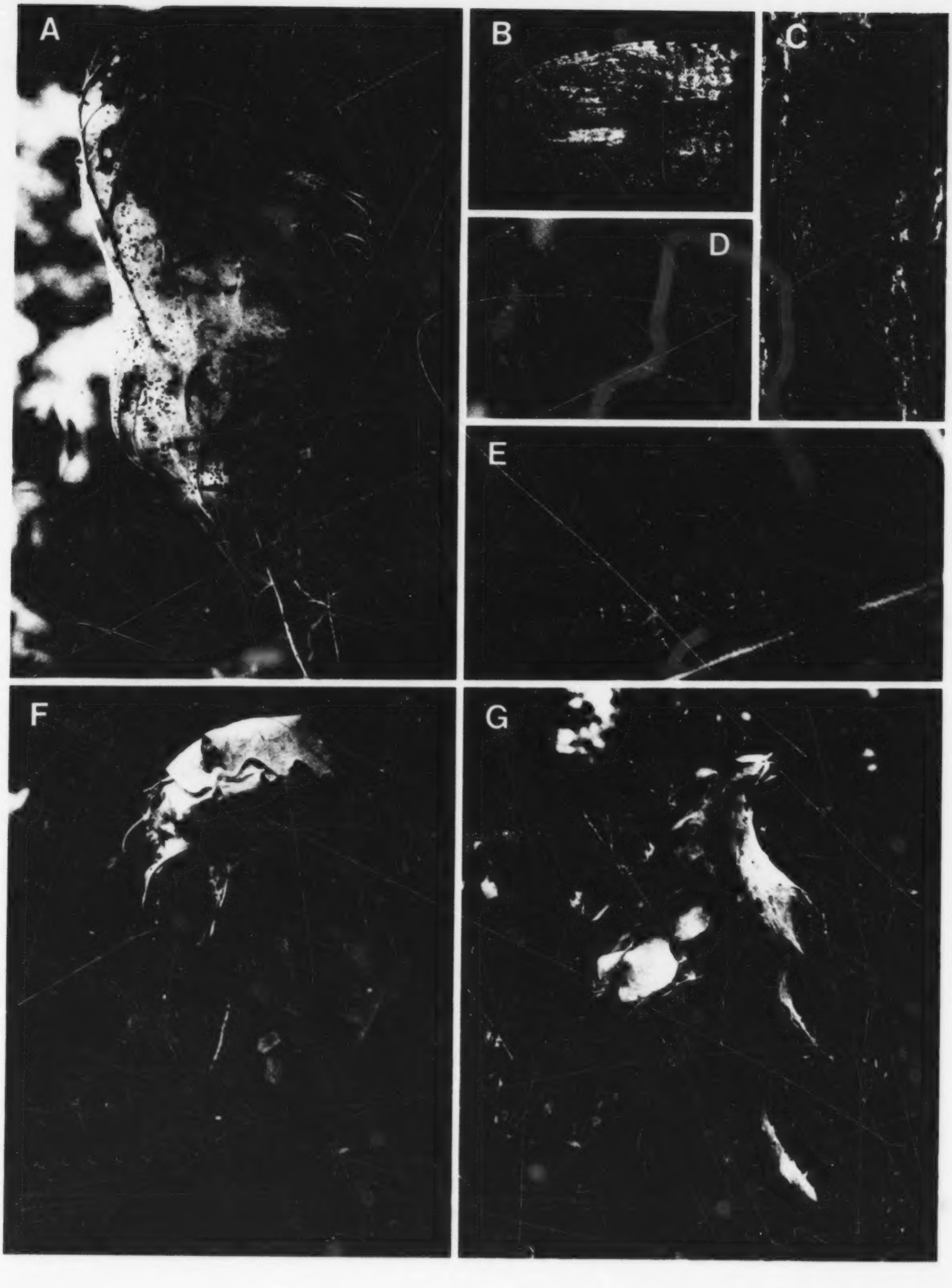
* Photographs courtesy of Great Lakes Forestry Centre.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TENT-FORMING INSECTS (Figure 73)

Distribution, Hosts, and Importance

Several species of insects besides tent caterpillars form silken tents in which the larvae feed. The most common in the prairie provinces is the uglynest caterpillar, ***Archips cerasivorana*** (Fitch). It usually feeds on choke cherry but sometimes attacks pin cherry and other hardwood trees and shrubs. It can become a serious pest on Schubert choke cherry in nurseries and ornamental plantings. Another common tent-forming insect is the fall webworm, ***Hyphantria cunea*** (Drury). It attacks white birch, pin cherry, willow, white elm, choke cherry, speckled alder, and a wide variety of other hardwood trees and shrubs. No major outbreaks have been reported in the prairie provinces, although they occur frequently in eastern Canada. The oak webworm, ***Archips fervidana*** (Clemens), feeds on bur oak, and its tents are occasionally found in Manitoba.

Life Cycle and Appearance

Archips cerasivorana has one generation per year and overwinters in the egg stage. The adults are active from late June to early September. They have dull reddish orange heads, thoraxes, and front wings and have wingspans of 20-24 mm (B). The front wing is crossed with reddish brown striations and has an irridescent sheen. The hind wing is bright orange. The females deposit their eggs in masses on the host plant (C). Larvae have yellowish bodies and dark brown or black heads, thoracic shields, and anal shields (D). There is a brown spot at the base of each seta. Mature larvae are 20-23 mm long and may be yellowish or a dark yellowish green in color. All larval stages are gregarious and live in silk-covered tents or nests that become filled with frass as the larvae grow (G).

Hyphantria cunea overwinters in the pupal stage and has one generation per year in the prairie provinces. Adults emerge from late June to mid-July and have a wingspan of 30–40 mm. Moths in this region are white without markings. Mature larvae (E) are about 25 mm long and are covered with long silky hairs arising from tubercles. They have whitish bodies with a broad black dorsal stripe or band. The tubercles in this band are also black, but those on the sides are orange. The larvae feed in silk-enclosed nests (A), which are enlarged as necessary to accommodate the food requirements of the colony. Several branches may be enclosed in the webbing spun by one large colony.

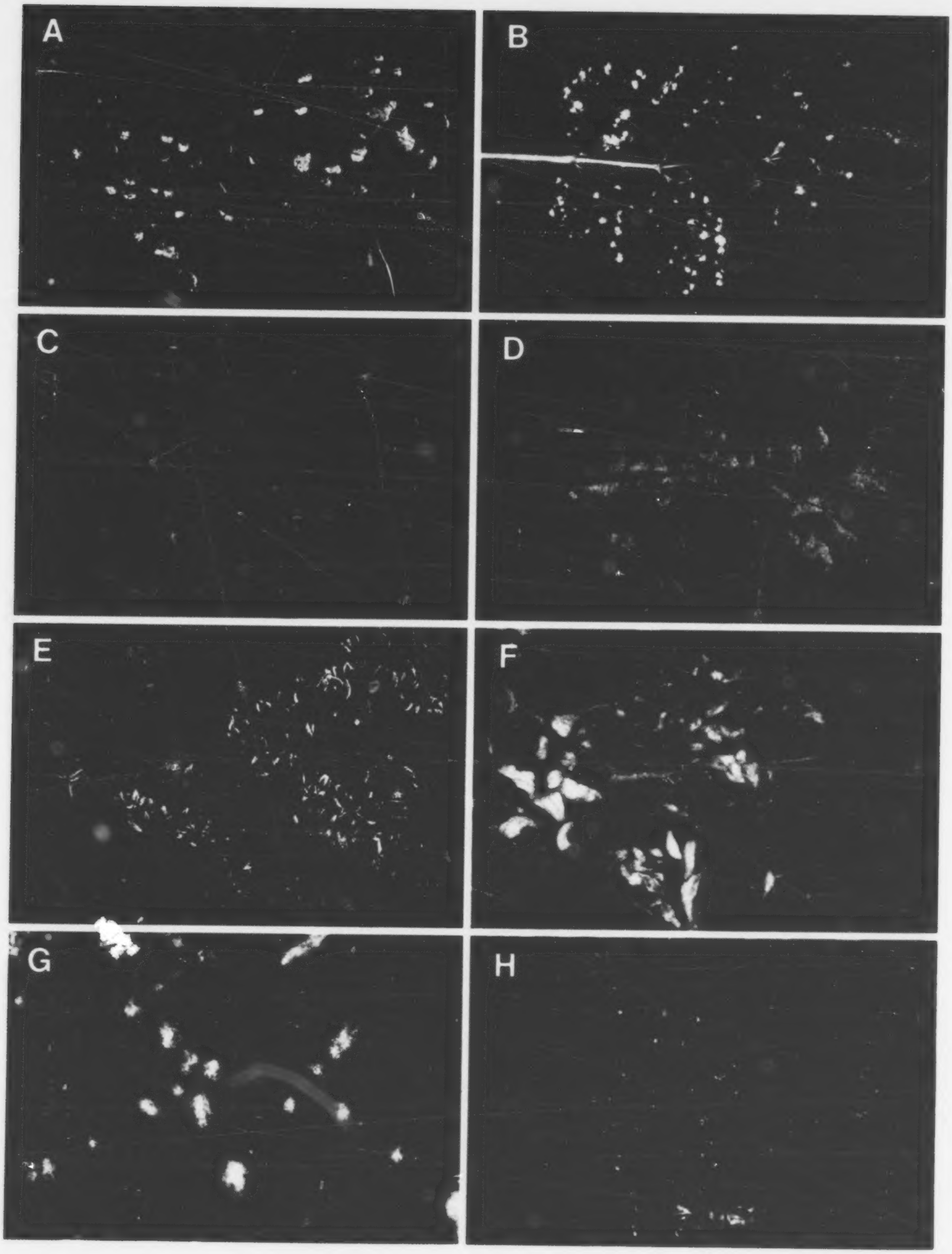
Archips fervidana has one generation per year and overwinters in the egg stage. The larvae feed within web-enclosed nests (F). They are about 20 mm long when fully grown, are a grayish green in color, and transform to pupae within the nests. Adults emerge in July or August and have a wingspan of 18-25 mm. The moths are brownish in color. The front wings are yellowish brown with darker patches, and the hind wings are smoky.

Damage

Archips cerasivorana can be a problem in nurseries or ornamental plantings because of the unsightly appearance of the nests. The nests may also cause some branch deformity in subsequent years but little other permanent damage. The nests of ***H. cunea*** are very unsightly in ornamental plantings. In the forest, most nests are on undergrowth and are seldom abundant enough to be of major concern. ***Archips fervidana*** is never abundant enough to cause much damage.

Bibliography: 17, 139, 297, 368, 476, 598

Figure 73. Tent-forming insects. A. Fall webworm, *Hyphantria cunea* (Drury), nest. **B.** Adult uglynest caterpillar, *Archips cerasivorana* (Fitch). **C.** *A. cerasivorana* egg mass. Most eggs have hatched. **D.** *A. cerasivorana* larva. **E.** *H. cunea* larva. **F.** Oak webworm, *A. fervidana* (Clemens), nest. **G.** *A. cerasivorana* nest.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MITE GALLS AND ERINEA (Figure 74)

Distribution, Hosts, and Importance

Minute mites are the cause of galls and erinea (feltlike growths) on the leaves of many hardwood trees and shrubs. This is a complex and difficult group of acarids, and the taxonomic status of some of the species has yet to be determined.

Mites in the genus ***Eriophyes*** cause the formation of bladderlike galls on a number of hosts. Those on trembling aspen and black ash are shown. Mites responsible for the erinea on mountain maple and speckled alder leaves are probably the purple erineum maple mite, ***E. calaceris*** (Keifer), and an undetermined species of *Eriophyes*, respectively. ***Aceria ulmi*** (Garman) produces fingerlike pocket galls on the upper surface of white elm leaves. ***Eriophyes* nr. *padi*** (Nalepa) and ***E. emarginatae*** Keifer (they may be synonymous) produce similar galls on the upper surfaces of wild plum and choke cherry leaves, respectively. The maple bladder gall mite, ***Vasates quadripedes*** Shimer, causes bladderlike galls on the upper surface of silver maple leaves. None of these mites are of economic importance, but populations may occasionally reach very high densities in localized areas wherever their hosts occur.

Life Cycle and Appearance

These mites are small, wormlike creatures about 0.2 mm long with two pairs of legs. They evolved more than 30 million years ago and have gradually developed rather specific relationships with a wide variety of hosts. Some are vagrants, depending upon the hairs on the leaves of their host for protection, others cause rustlike growths, and still others cause galls or erinea to form on their hosts. Examples of the latter two types will be discussed.

All of these mites, with the exception of the ***Eriophyes*** on plum and choke cherry, have similar life cycles, but their small size and the large number of species have made taxonomic relationships hard to evaluate. It is reasonably certain, however, that the ***Eriophyes*** species shown (A–D) are different species because the hosts are not closely related and the bladder galls (A, B) differ from the erinea (C, D).

Fertilized females that are adapted for long-term survival overwinter in bark crevices on their hosts. They move onto the foliage in the spring and stimulate gall or erinea formation by injecting saliva into the host tissues. The bladder or pocket galls are on the upper leaf surface, with pores opening to the underside (A, B, E–H), but erinea may be on the upper (C) or lower (D) leaf surface. The mites move into the galls or between the hairlike projections of the erinea once these are formed. Mite dispersal is primarily on wind currents.

The overwintered females lay eggs that hatch, pass through two nymphal instars, and develop into male and female mites that are identical except for the genital organs. The males deposit packets of sperm on the host tissue, and these are picked up by the females. The females live for about 1 month, and several generations are completed during the summer. A generation of overwintering females is produced when the leaf tissue starts to harden in the fall. The females are fertilized by the sperm packets and then move off the leaves to hibernate on the twigs or branches.

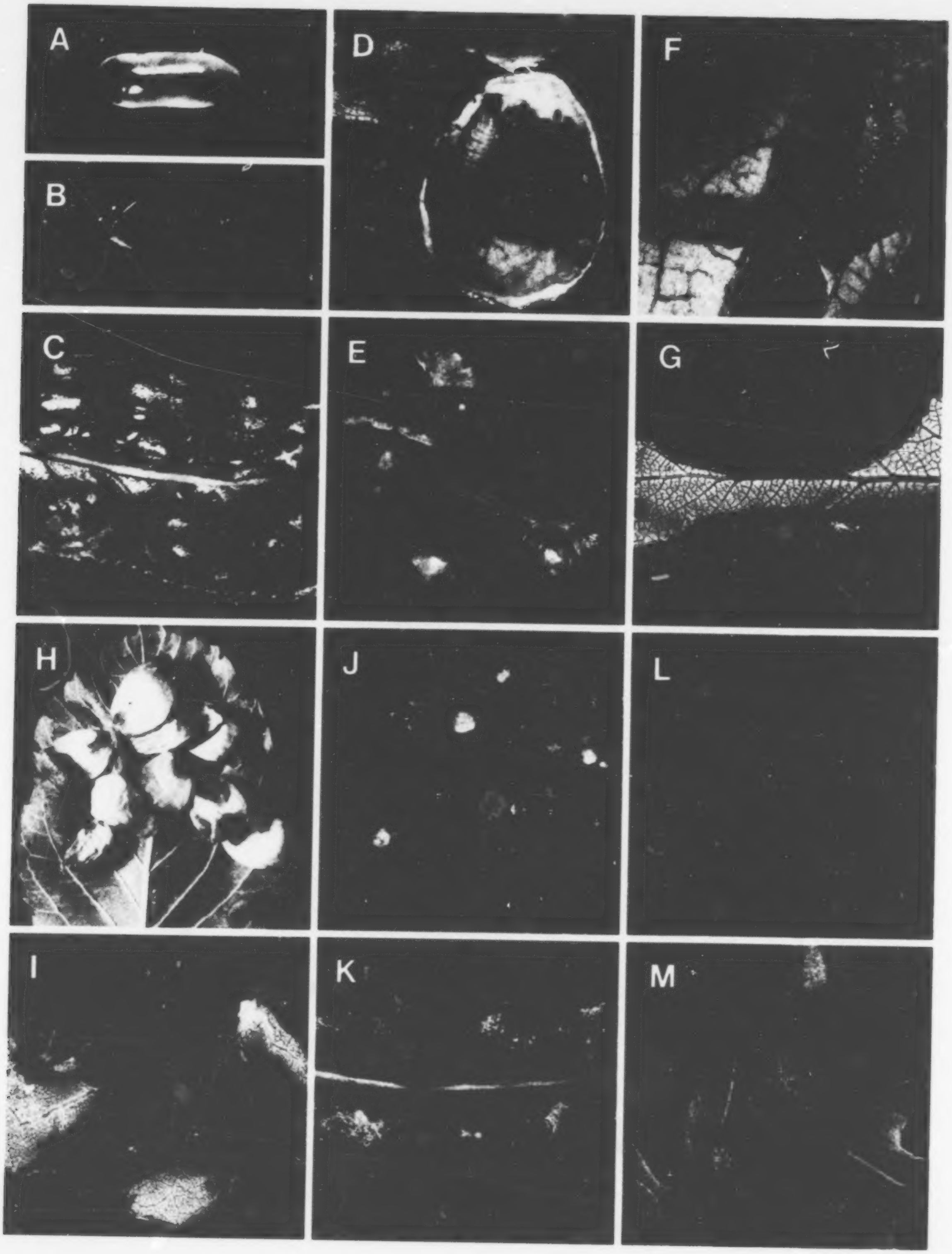
The ***Eriophyes*** species on plum and choke cherry are interesting because they have lost the summer females. The overwintering females move onto the foliage in the spring and induce gall formation. Their eggs develop into males and more overwintering females. There is consequently only one generation per year, because the females vacate the galls to hibernate as soon as they are fertilized.

Damage

The galls or erinea produced by these mites cause little damage to their hosts, but severe infestations create an unsightly appearance that is undesirable in ornamental plantings.

Bibliography: 230, 295, 305

Figure 74. **Mite galls and erinea. A.** Bladder galls on trembling aspen leaves caused by *Eriophyes* sp. **B.** Bladder galls on black ash leaf caused by *Eriophyes* sp. **C.** Erinea on mountain maple leaf caused by *Eriophyes* sp. (probably the purple erineum maple mite, *E. calaceris* (Keifer)). **D.** Erinea on speckled alder leaf caused by *Eriophyes* sp. **E.** Pocket galls on white elm leaves caused by *Aceria ulmi* (Garman). **F.** Pocket galls on wild plum leaf caused by *E.* nr. *padi* (Nalepa). **G.** Pocket galls on choke cherry leaf caused by *E. emarginatae* Keifer. **H.** Bladder galls on silver maple leaf caused by the maple bladder gall mite, *Vasates quadripedes* Shimer.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MISCELLANEOUS INSECT GALLS (Figure 75)

Distribution, Hosts, and Importance

A wide variety of insect-induced galls occur on various trees and shrubs in the prairie provinces. It is not feasible to attempt to discuss more than a few of them. The ones shown were selected to give some idea of the types of leaf galls that are caused by insects.

The willow redgall sawfly, ***Pontania proxima*** (Lepeletier), a European species, attacks various willows throughout the prairie provinces. An unidentified ***Pontania*** species produces spherical galls on sandbar willow. ***Phyllocolpa* nr. *agama*** (Rohwer) folds the leaf edges of balsam poplar and other poplar species. Cecidomyiid midges cause galls on several hosts; those on saskatoon and trembling aspen are shown. Jumping plant lice belonging to the genus ***Pachypsylla*** cause small, nipple-shaped galls on a variety of hosts, particularly hackberry. Galls caused by one of the species on choke cherry are shown. The aphid ***Parathecabius populimonilis*** (Riley) forms galls along the edges of balsam poplar leaves. Tiny cynipid wasps cause many different types of leaf galls on bur oak. Two of the galls caused by ***Neuroterus*** species are given as examples. Some of these gall makers become very abundant in localized areas, but none are of economic importance.

Life Cycle and Appearance

Pontania proxima and the unidentified *Pontania* species have similar life cycles. Both species have one generation per year in the prairie provinces and overwinter as prepupae in cocoons spun in the duff in the fall. The adult sawflies emerge in late spring and deposit their eggs (A) in slits cut into the leaf tissue. This initiates gall formation, but larval feeding further stimulates growth of the galls. ***Pontania proxima*** larvae (B) are pale green with black heads, and the oval galls (C) may occur in rows on either side of the midrib. The ***Pontania*** species larvae (D) are creamy colored with dark brown heads, and the galls (E) are spherical in shape, reaching a diameter of about 12 mm when the larvae are fully grown. ***Phyllocolpa* nr. *agama*** has one generation per year and overwinters as prepupae in cocoons spun in the duff. The small adult sawflies emerge in late spring and lay their eggs near the edge of the leaves. This stimulates the leaf to fold (G), and the larvae feed within the shelter thus provided. The larvae (F) are yellowish green with brown heads and reach a length of 10–12 mm when mature.

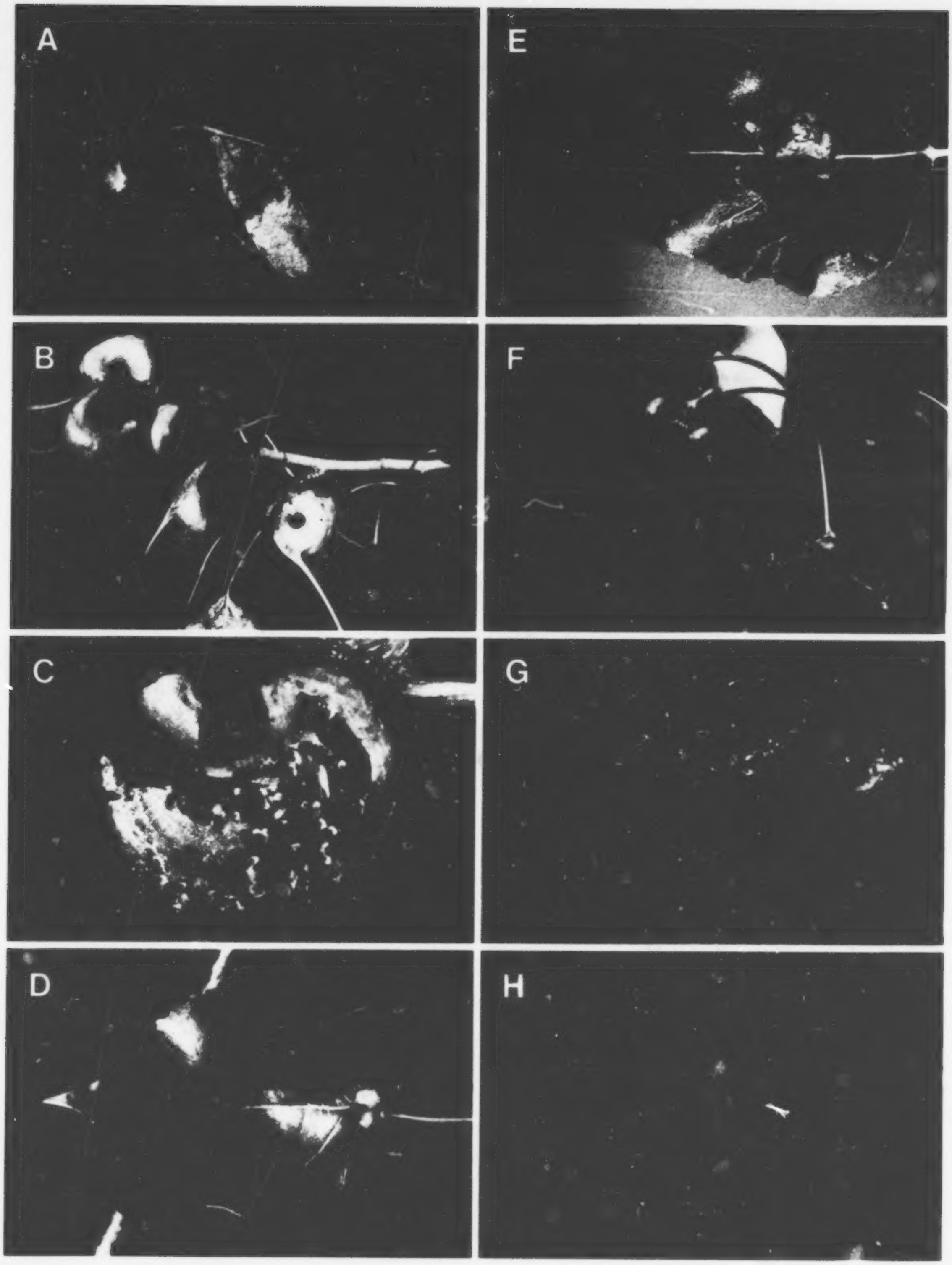
Very little is known about the taxonomy or life histories of the insects causing the remaining galls that are illustrated. The pocket galls on saskatoon (H) and the large purplish galls on trembling aspen (I) are caused by cecidomyiid midges. The adults are slender flies and the larvae are small, legless maggots. ***Pachypsylla*** species adults resemble miniature cicadas (Figs. 31, 78), but their hind legs are suited for jumping. The nymphs look like small aphids, and the galls (J) resemble those caused by eriophyid mites (Fig. 74). The beadlike galls (K) on balsam poplar leaves are caused by the aphid ***Parathecabius populimonilis***. The small disc-shaped galls (L) and spherical galls (M) on bur oak are caused by two different species of ***Neuroterus***. They are two examples of the wide variety of leaf galls on bur oak that are caused by cynipid wasps. These are tiny insects that typically have complicated life histories. Many of the relationships have yet to be determined, but accumulating evidence suggests that most gall-forming cynipids probably have alternating generations of sexual and parthenogenetic forms. The parthenogenetic females overwinter, usually as larvae, in galls formed during the summer. These females emerge in early spring and lay their eggs in the buds. Larvae hatching from these eggs develop into male and female wasps that emerge in early summer. The females mate, and their progeny become the overwintering generation. The galls formed by the two generations are often dissimilar.

Damage

None of these galls seriously damage their hosts, but severe infestations are unsightly and may cause premature leaf drop. ***Pontania proxima*** may seriously detract from the appearance of some European willows planted as ornamentals.

Bibliography: 38, 81, 135, 170, 179, 342, 360, 479, 480, 483, 524, 532, 607, 651

Figure 75. **Miscellaneous insect galls. A.** Willow redgall sawfly, *Pontania proxima* (Lepeletier), egg. **B.** *P. proxima* larva. **C.** *P. proxima* galls on willow leaf. **D.** *Pontania* sp. larva. **E.** *Pontania* sp. gall on willow leaf. **F.** *Phyllocolpa* nr. *agama* (Rohwer) larva. **G.** Folded balsam poplar leaf containing *P.* nr. *agama* larva. **H.** *Cecidomyia* sp. galls on saskatoon leaf. **I.** Cecidomyiid galls on trembling aspen leaf. **J.** *Pachypsylla* sp. galls on choke cherry leaf. **K.** *Parathecabius populimonilis* (Riley) galls on balsam poplar leaf. **L.** *Neuroterus* sp. galls on bur oak leaf. **M.** *Neuroterus* sp. galls on bur oak leaf.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PEMPHIGUS GALLS (Figure 76)

Distribution, Hosts, and Importance

A number of galls on the petioles or midribs of the leaves are caused by aphids in the genus *Pemphigus*. This group of insects requires further study to clarify taxonomic relationships, because several species have alternating generations that are on different hosts or different parts of the same host. Some have been identified as different species because the alternating generation was not recognized.

The lettuce root aphid, ***Pemphigus bursarius*** (Linnaeus), is a European insect that was accidentally introduced into North America and is now found as far west as Alberta. It alternates between hybrid poplars and lettuce. The poplar petiolegall aphid, ***P. populitransversus*** Riley, alternates between cottonwoods and cruciferous hosts. ***Pemphigus betae*** Doane alternates between narrowleaf cottonwood or balsam poplar and beets. Several other *Pemphigus* species occur on various poplars in the prairie provinces. None of these insects are of economic importance to a forester or arboriculturist, but some of the *Pemphigus* species are potentially serious pests on their alternate hosts.

Life Cycle and Appearance

All of the gall-producing *Pemphigus* species are believed to have similar life histories, although the shape of the galls on poplars vary. ***Pemphigus bursarius*** will be used as an example. It overwinters in the egg stage on poplars. The eggs hatch in the spring, more or less coincident with the flushing of the poplar foliage. The young, parthenogenetic, wingless females move onto the developing petioles, where their feeding stimulates the formation of hollow, flask-shaped galls (A, B). They mature in about 2 weeks and give birth to numerous (100-250) offspring (C) that develop into parthenogenetic winged females in about another 2 weeks. These females seek out lettuce plants, where they give birth to their young on the foliage or nearby soil. These young aphids soon move into the soil in search of a lettuce root, where they develop into wingless females. They produce more young, active aphids, which may settle near their mother or move to another part of the root. The aphid colony secretes a waxy substance that is believed to protect the aphids from excess moisture. A winged generation is produced in the fall, and these fly back to poplars, where they give birth to small, mouthless aphids. These develop into males and females that are less than 1 mm long. After mating, each female produces a single egg that is nearly as large as herself.

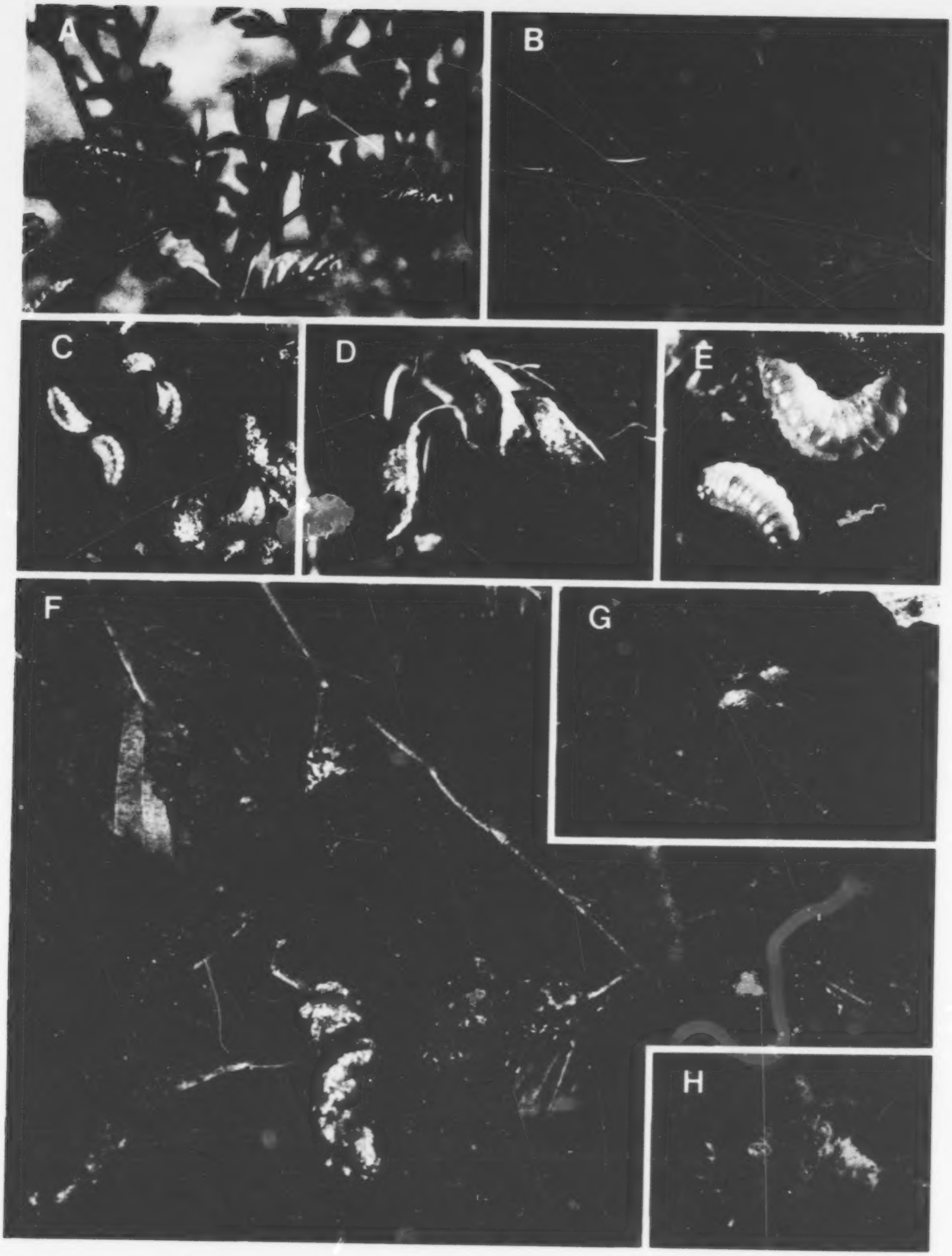
The life cycles of the other *Pemphigus* species are probably similar. The types of galls vary, and more than one species sometimes occurs on one leaf (H). Most of the galls tend to be somewhat globular in shape. ***Pemphigus populitransversus*** adults emerge through a transverse slit in the gall (D). Other species escape through pores or spiral slits. ***Pemphigus populivenae*** Fitch (E) and unidentified species of ***Pemphigus*** (F-H) show the variation in gall shapes and locations.

Damage

The foliage galls produced by these insects (A, B, D-G) cause little damage to their hosts, but severe infestations make the trees unsightly.

Bibliography: 4, 150, 179, 225, 226, 238, 239, 301

Figure 76. ***Pemphigus* galls. A.** Young gall on Griffin poplar caused by the lettuce root aphid, *Pemphigus bursarius* (Linnaeus). **B.** Mature *P. bursarius* galls on Griffin poplar. **C.** Cross-section of *P. bursarius* gall on Griffin poplar showing aphids inside. **D.** Gall on cottonwood leaf caused by the poplar petiolegall aphid, *P. populitransversus* Riley. **E.** Gall on balsam poplar leaf caused by *P. populivenae* Fitch. **F.** *Pemphigus* sp. galls on balsam poplar leaves. **G.** *Pemphigus* sp. galls on balsam poplar leaves. **H.** *Pemphigus* spp. galls on poplar petioles.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DEFORMED LEAVES (Figure 77)

Distribution, Hosts, and Importance

Several species of insects cause leaf deformation of their hosts. The ash midribgall midge, ***Contarinia canadensis*** Felt, and the boxelder leaf gall midge, ***C. negundifolia*** Felt, attack ash and Manitoba maple, respectively. The aphid ***Asiphum pseudobrysum*** (Walsh) feeds on cottonwood. The woolly elm aphid, ***Eriosoma americanum*** (Riley), alternates between white elm and saskatoon and is found wherever both of these hosts occur. The woolly apple aphid, ***E. lanigerum*** (Hausman), alternates between various elms and apple, mountain ash, or hawthorn. It seems to have lost its ability to infest elm in western North America and Europe. Any of these insects may become locally abundant, but none are of economic importance to the forester.

Life Cycle and Appearance

Contarinia negundifolia has one generation per year and overwinters as pupae in cocoons formed within earthen cells. The slender adult midges emerge in early spring, more or less coincident with the first flushing of Manitoba maple foliage. The adults mate in the grass or on the trunks. The females begin ovipositing a few days later, inserting their eggs between the edges of still-folded leaflets that measure between 6 and 20 mm in length. Smaller or larger leaflets are unsuitable for receiving eggs. The larvae (E) are typical white or yellow maggots, and they pass through three instars. Their feeding stimulates the formation of fleshy galls (B) along the midribs or lateral veins. The larvae apparently obtain nutrients from the inside of the galls without destroying the host tissues. Mature larvae drop to the ground in early summer and penetrate the soil almost immediately. The larvae are unusual in three respects. Normal movement is by crawling, but they are also believed to be able to skip or jump as far as 10 cm. The larvae also spin cocoons rather than forming the usual puparia. These cocoons are constructed in earthen cells about 1 week after the larvae drop from the trees. Pupation does not occur until early fall, when the pupal antennae protrude through the cocoon. Little is known about the life cycle of ***C. canadensis***, but it is probably similar to that of *C. negundifolia*. Eggs are laid in the veins of unfurling ash leaflets (A). The feeding of the whitish larvae (C) stimulates the formation of fleshy galls along the midribs or lateral veins of the leaflets. The length of the galls varies between 10 and 30 mm.

Little is known about the life cycle of ***A. pseudobrysum***. The parthenogenetic females feed on the undersides of the leaves near the midribs. This stimulates the formation of small, blister-like pseudogalls in which the females remain. The cavities are so small, however, that the young aphids must move onto the underside of the leaf surfaces. These nymphs secrete a white powdery wax that coats the lower leaf surfaces. The feeding of the aphids causes the two halves of the leaves to gradually fold towards each other until they come together (D). It is not known if there is an alternate host for this aphid. Winged females are produced, but they are believed to be weak flyers.

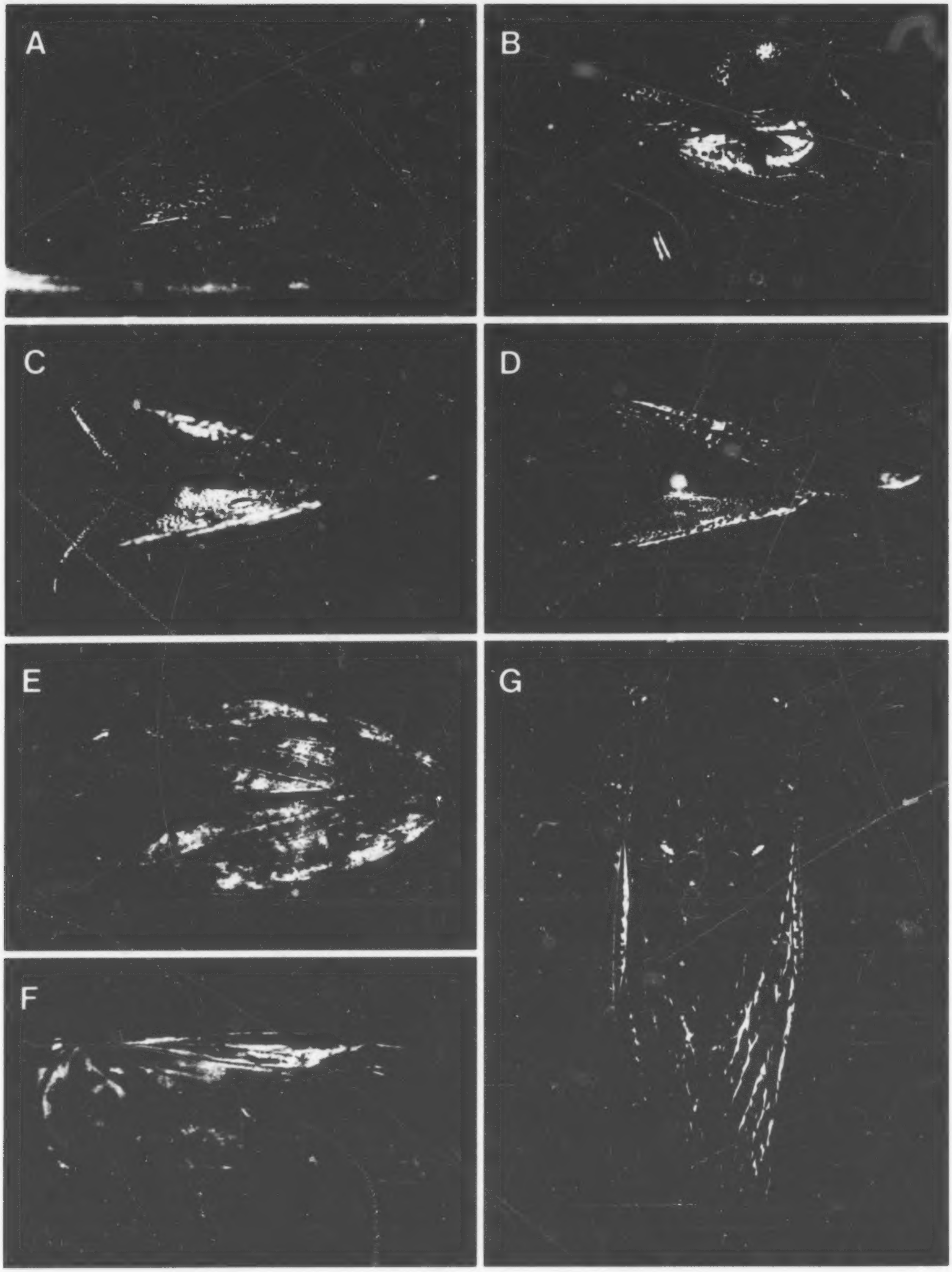
The life cycles of ***E. americanum*** and ***E. lanigerum*** are similar. Both species overwinter as eggs deposited in bark crevices. Female nymphs hatching from these eggs move onto the elm foliage. The feeding of *E. americanum* stimulates leaf curl (F); that of *E. lanigerum* causes rosette formation (H). Dense colonies of parthenogenetic female aphids develop. They secrete a powdery white wax (G) and copious amounts of honeydew. Winged female adults are produced in early summer, and these fly to the alternate hosts. *Eriosoma americanum* soon migrate to the roots of saskatoon. Some *E. lanigerum* move to the roots of their alternate hosts, but most remain on the stem, where they develop into dense colonies of woolly aphids. This aphid can maintain itself indefinitely on the alternate hosts and has lost its ability to infest elm in parts of its range. A winged generation of females develops in the fall. These females migrate back to elm, where they give birth to male and female aphids. The tiny, mouthless females mate, and each deposits a single egg to complete the life cycle.

Damage

None of these insects cause serious damage to their hosts. Heavy infestions create an unsightly appearance, however, and the honeydew produced by the aphids is often objectionable.

Bibliography: 4, 250, 254, 286, 297, 476, 524, 619

Figure 77. Deformed leaves. A. Young ash leaflets infested by the ash midribgall midge, *Contarinia canadensis* Felt. **B.** Manitoba maple leaves infested by the boxelder leaf gall midge, *C. negundifolia* Felt. **C.** *C. canadensis* larvae. **D.** Cottonwood leaves infested by an unidentified aphid species, possibly *Asiphum pseudobrysum* (Walsh). **E.** *C. negundifolia* larvae. **F.** White elm leaves infested by the woolly elm aphid, *Eriosoma americanum* (Riley). **G.** *E. americanum* female and young nymphs. **H.** White elm leaves infested by the woolly apple aphid, *Eriosoma lanigerum* (Hausman).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TREEHOPPERS AND THEIR ALLIES (Figure 78)

Distribution, Hosts, and Importance

Treehoppers are a large group of sucking insects in which many species have a bizarre appearance. ***Telamona scalaris*** (Fairmaire), on choke cherry, and ***T. spreta*** Goding, on bur oak, were collected in central Alberta and southeastern Manitoba, respectively. *Telamona scalaris* is usually found on hawthorn. ***Cyrtolobus tuberosus*** (Fairmaire) and ***C. pallidifrontis*** (Emmons) both feed on bur oak in southern Manitoba. The buffalo treehopper, ***Ceresa bisonia*** (Kopp & Yonke), erroneously referred to as *Stictocephala bubalus* (Fabricius) in early North American literature, lays its eggs in the twigs of many hardwood trees including poplar, willow, elm, oak, and hazel and ranges west to Manitoba. ***Ceresa diceros*** (Say) lays its eggs in elm, oak, and hazel and probably occurs throughout the ranges of these hosts.

The diamondbacked spittlebug, ***Lepyronia quadrangularis*** (Say), attacks a wide variety of plants, including hardwood trees and shrubs, and is found throughout the aspen parkland area of the prairie provinces.

There are several hundred species of leafhoppers on agricultural crops and on forest trees and shrubs. ***Idiocerus lachrymalis*** Fitch is an example of a species feeding on trembling aspen and probably willow.

The dogday cicada, ***Tibicen pruinosa*** (Say), is the only member of the genus known to occur in the prairie provinces. It is found among deciduous trees as far west as Saskatchewan.

None of these insects are currently considered to be of economic importance.

Life Cycle and Appearance

Most treehoppers have one generation per year and overwinter in the egg stage. Identification of the adults is based primarily upon the shape and coloration of the pronotum, which is greatly enlarged and covers much of the upper body.

Telamona scalaris adults (A) are 8-10 mm long and are mahogany or dark purplish brown. The shape of the crest on the pronotum is variable but is usually larger than on the specimen shown. ***Telamona spreta*** adults (not shown) are similar to those of *T. scalaris*, but the crest is rectangular instead of rounded. The genus *Cyrtolobus* contains a number of poorly defined and variable species. ***Cyrtolobus tuberosus*** adults (B) are 8-9 mm long, have a strongly arched pronotum, and are a mottled brown tinged with green. ***Cyrtolobus pallidifrontis*** adults (not shown) are similar in appearance but are only 5.5 mm long. ***Ceresa bisonia*** adults (C) are 8-10 mm long and are green in color when alive. The front of the pronotum extends into a pair of horns, which gives the insect a superficial resemblance to a buffalo. The female lays her eggs in slits cut into the twigs of various trees and shrubs. The nymphs hatch the following spring, then drop to the forest floor and feed on herbaceous vegetation. Adults fly to the trees in late summer and repeat the cycle. ***Ceresa diceros*** adults (D) are similar in size and shape to those of *C. bisonia* but are hairy and dark brown.

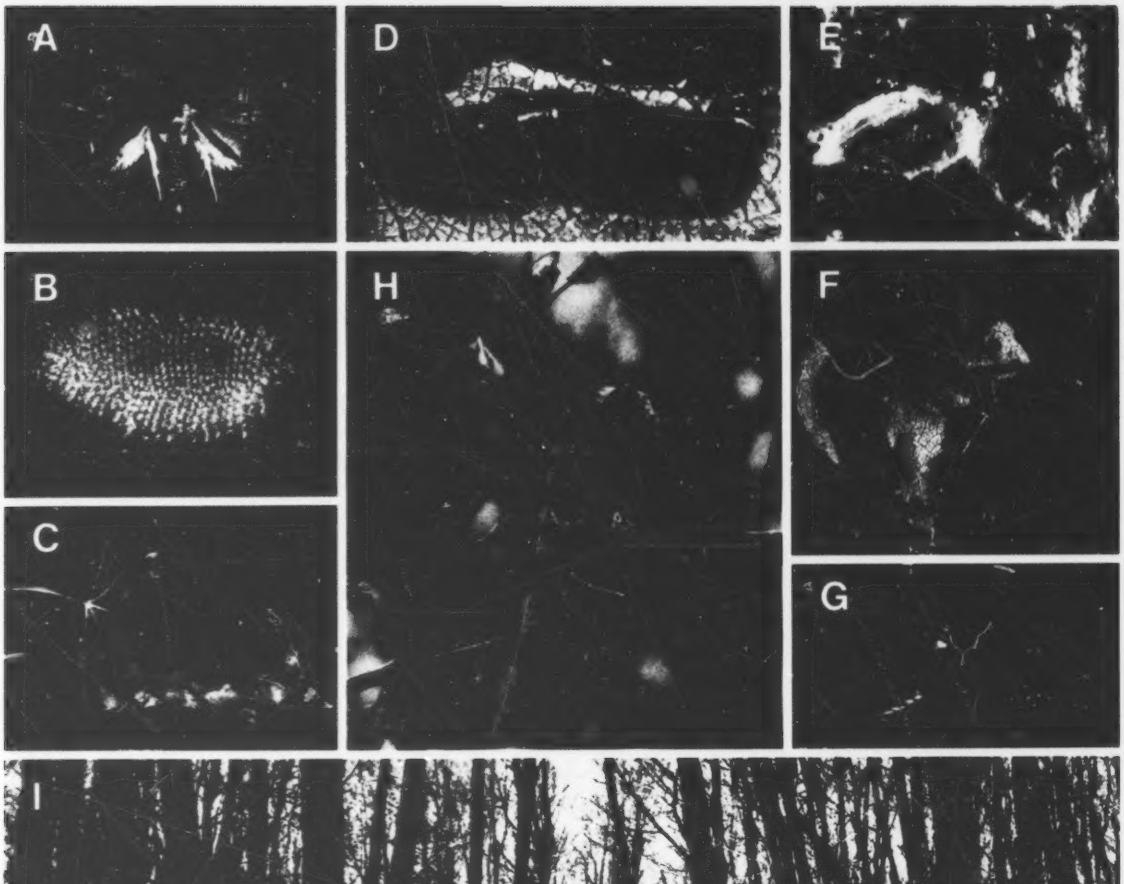
Lepyronia quadrangularis adults (E) are 6-8 mm long. The front wings are almost flat and are more than twice as long as wide. They vary in color from tawny through orange-brown to dark brown and have a blackish brown diamond-shaped mark on the front wings. The adults overwinter in the duff and lay their eggs in the host tissue in the spring. There is one generation per year. The nymphs have five instars and feed on the same hosts as the adults. ***Idiocerus lachrymalis*** adults (F) are 5.5-7.5 mm long and have a yellowish head with two black dots between the eyes. The color and markings are variable, but the front wings are usually grayish in live insects and are darker than the head and thorax. There is probably one generation per year, and the eggs are laid in host tissues. There are five nymphal instars, and the nymphs feed on the same hosts as the adults. ***Tibicen pruinosa*** adults (G) are 41-55 mm long and are black with green or yellowish green markings. The females lay their eggs in pockets cut into the host twigs, and the nymphs drop to the ground. They then burrow into the soil and feed on the roots of the host. Development to the adult stage requires several years.

Damage

This group of insects causes two types of damage. Oviposition damage on shoots may cause desiccation and death of the twigs or provide an entry for disease organisms. Nymphal and adult feeding removes plant sap and may cause mottling of the leaves if populations are heavy. Leafhoppers may be vectors of virus diseases, but this requires verification.

Bibliography: 31, 32, 128, 129, 139, 232, 297, 317, 318, 319, 320, 321, 415, 476

Figure 78. Treehoppers and their allies. A. Adult *Telamona scalaris* (Fairmaire). **B.** Adult *Cyrtolobus tuberosus* (Fairmaire). **C.** Adult buffalo treehopper, *Ceresa bisonia* (Kopp & Yonke). **D.** Adult *C. diceros* (Say). **E.** Adult diamondbacked spittlebug, *Lepyronia quadrangularis* (Say). **F.** Adult *Idiocerus lachrymalis* Fitch. **G.** Adult dogday cicada, *Tibicen pruinosa* (Say).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THE LARGE ASPEN TORTRIX (Figure 79)

Distribution, Hosts, and Importance

The large aspen tortrix, ***Choristoneura conflictana*** (Walker), is a defoliator of trembling aspen, although the foliage of willow and balsam poplar are sometimes eaten. Outbreaks are often extensive and tend to precede those of the forest tent caterpillar. The outbreaks usually last for 2 or 3 years and often seem to end soon after contemporaneous forest tent caterpillar populations reach outbreak proportions.

Life Cycle and Appearance

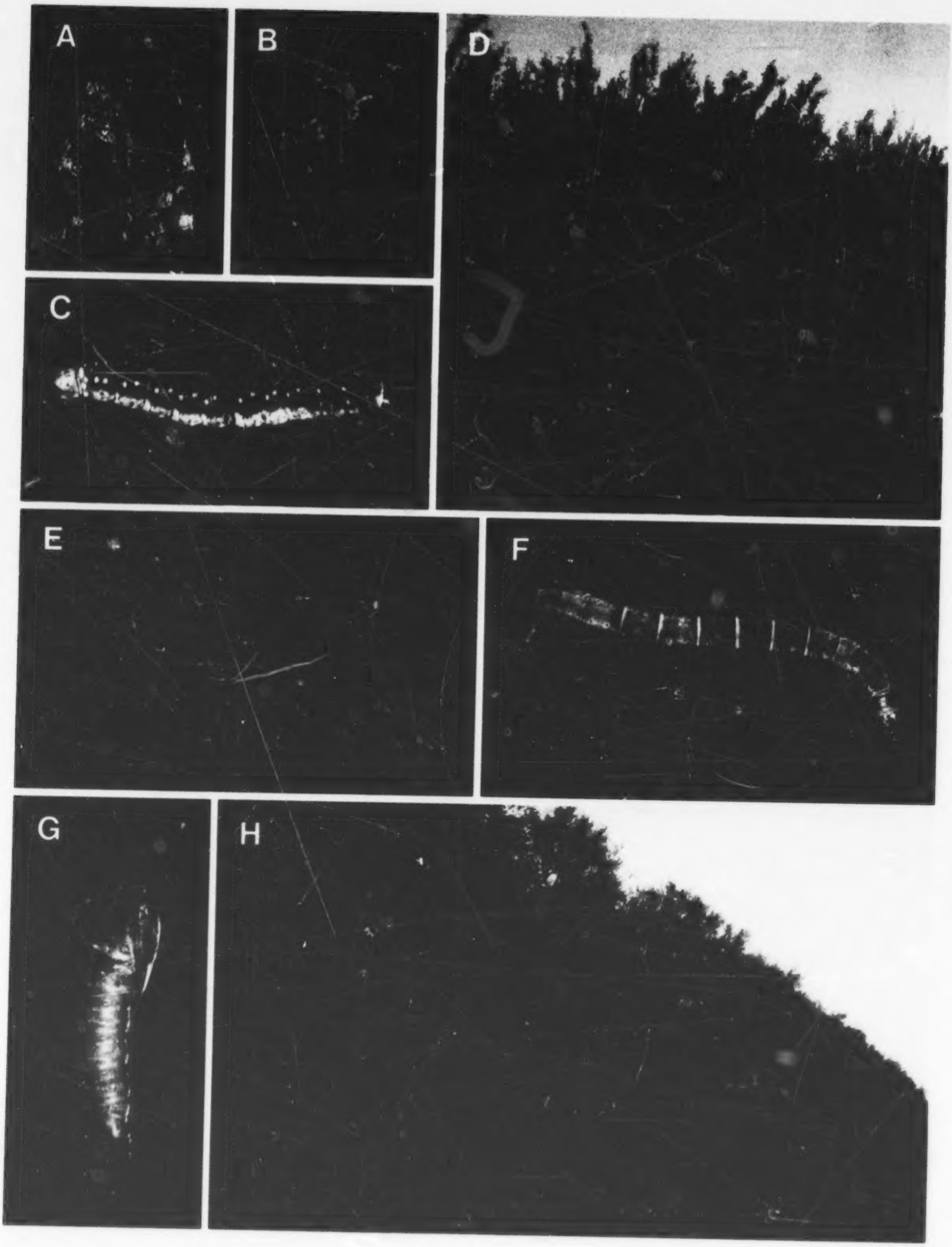
Choristoneura conflictana has one generation per year. The overwintering second-instar larvae emerge from hibernation when the trembling aspen buds begin to swell (about 10 days before the leaves appear). The young larvae have yellowish or pale green bodies and black heads. They mine the buds, and the second molt occurs within the bud. Older larvae pull leaves together with silken threads (F, H) and feed within the folded leaves. There are five larval instars, and the larvae become darker with each molt. Mature larvae (D) are 15-21 mm long and are dark green, almost black, in color. Pupation occurs in mid-June, and the adult moths emerge about 10 days later. The empty pupal cases (G) can often be seen protruding from the clumps of folded leaves. Adult females have a wingspan of 27-35 mm, and the males are slightly smaller. The fore wings are light gray and have an inner patch, a median band, and an outer patch of dark gray (A). The hind wings are smoky with a fringe of hairs along the posterior edge. The eggs are laid in clusters, mainly on the upper surface of the leaves (B) but almost anywhere if no aspen foliage is available. The eggs hatch in about 2 weeks. The young larvae web leaves together and feed on the epidermis of the leaves. They will also feed in leaves webbed together by the preceding generation (C). In mid-August the larvae cease feeding and seek out suitable sites under bark scales, dead bark, or moss for the spinning of hibernacula (E), in which they overwinter.

Damage

Defoliation by ***C. conflictana*** causes a reduction in radial increment of the tree, but the outbreaks seldom last long enough to cause any appreciable tree mortality. Large amounts of silk are sometimes spun by larvae in severe infestations (I), and this can be annoying to persons walking through aspen forests.

Bibliography: 28, 29, 115, 292, 455, 612, 640

Figure 79. The large aspen tortrix, *Choristoneura conflictana* (Walker). A. Adult *C. conflictana.* **B.** Egg mass. **C.** Young larvae of the current generation in leaves webbed together by preceding generation. **D.** Mature larva. **E.** Overwintering larvae in hibernacula. **F.** Leaves webbed together by feeding larvae. **G.** Pupal case protruding from leaves. **H.** Groups of leaves webbed together by feeding larvae. **I.** Defoliated trembling aspen stand. Note the copious amount of silk spun by wandering larvae.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LEAF ROLLERS OF CARAGANA AND MANITOBA MAPLE (Figure 80)

Distribution, Hosts, and Importance

Two closely related leaf rollers are occasional pests of common caragana and Manitoba maple in many prairie shelterbelts. The fruittree leafroller, ***Archips argyrospila*** (Walker), attacks fruit trees, caragana, and a variety of other hosts such as white birch, trembling aspen, basswood, willow, and bur oak. The larger boxelder leafroller, ***Archips negundana*** (Dyar), usually feeds on Manitoba maple but will feed on adjacent shrubs during severe infestations. Outbreaks of *A. argyrospila* on caragana and *A. negundana* on Manitoba maple are sporadic and short-lived and have been concentrated in Manitoba and Saskatchewan.

The boxelder leafworm, ***Chionodes obscurusella*** (Chambers), feeds on Manitoba maple throughout the region. No outbreaks have occurred in the prairie provinces, but severe defoliation of Manitoba maple by this insect has been reported in northern Ontario.

Life Cycle and Appearance

Archips argyrospila overwinters in the egg stage and has one generation per year. The larvae hatch in the spring and feed on the opening leaves, webbing them together with silk (B). Young larvae are pale green and have reddish brown to dark brown heads and amber thoracic shields. The dorsal surface of older larvae (C) is brownish or grayish with two rows of white spots, and the venter is light green. The larvae are about 25 mm long when fully grown. The pupae wriggle out from the webbed foliage before adult emergence, which occurs in July. The moths have a wingspan of about 20 mm. The front wings are variable in color and may be light brown, grayish brown, or reddish brown with silvery markings (A). Eggs are laid in clusters on the twigs of the host.

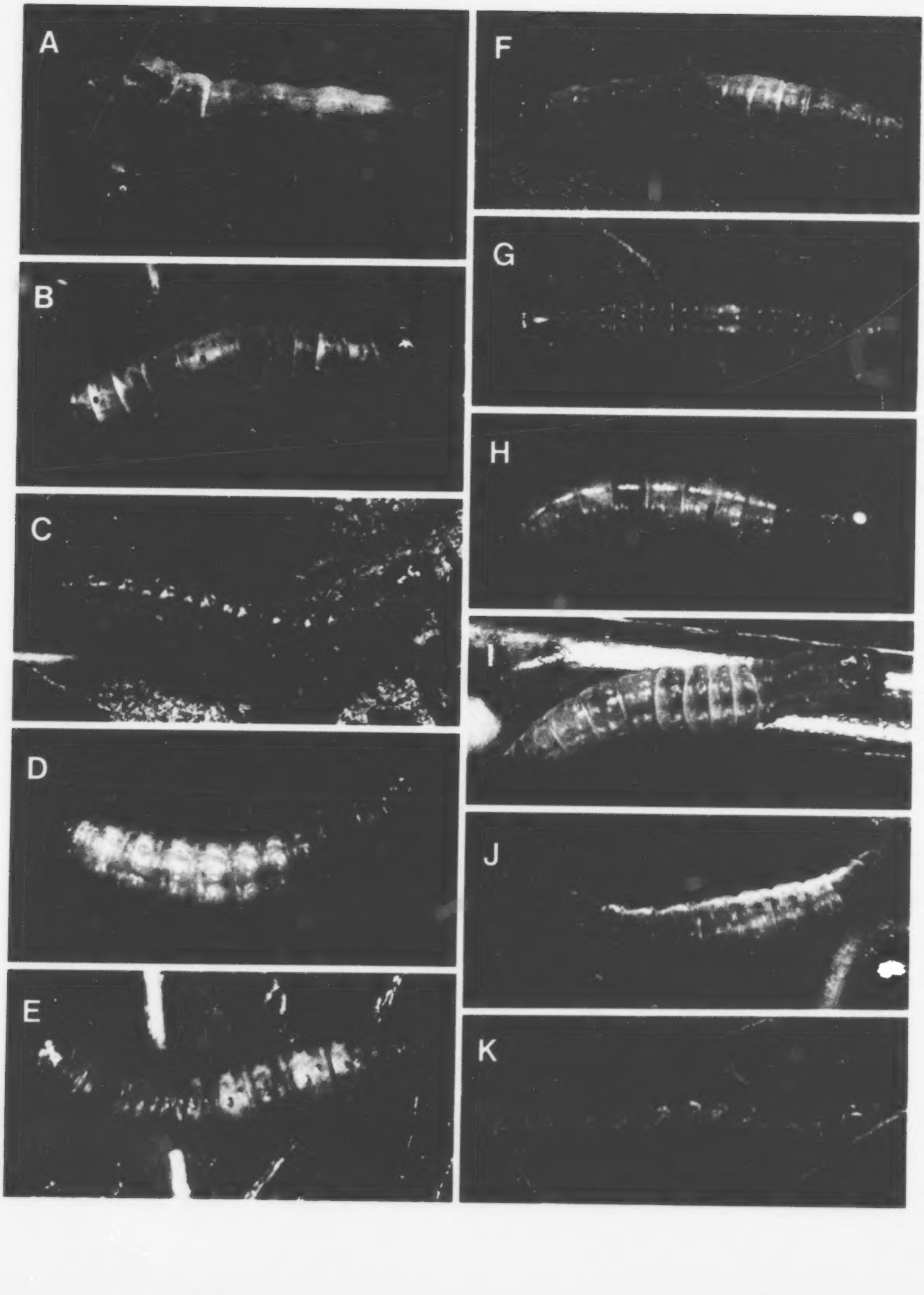
The life cycle of ***A. negundana*** is very similar to that of *A. argyrospila*. The larvae are green (E) and reach a length of about 20 mm when fully grown. The pupae (G) are pale green and have two prominent brown patches on the dorsal area of the first two abdominal segments. Moths are olive brown with darker patches and have a wingspan of 20-25 mm. Little is known about the life cycle of ***C. obscurusella***. The adults are nondescript moths with a wingspan of 15-18 mm. The front wings are brownish gray with dark markings. The hind wings are light gray. The larvae (F) are whitish green with indistinct, white subdorsal lines. They reach a length of about 20 mm at maturity.

Damage

Like most leaf rollers, ***A. argyrospila*** and ***A. negundana*** are wasteful feeders, and they often leave a large amount of foliage remnants entangled in silk webbing. The dead foliage on Manitoba maple often bleaches, giving the trees a whitish appearance (H). The dead foliage on caragana usually turns brown (D). The affected trees or shrubs are unsightly, and growth may be reduced if outbreaks last 2 or 3 years, but little tree mortality has been observed.

Bibliography: 94, 96, 139, 186, 193, 203, 297, 352, 358, 438

Figure 80. **Leaf rollers of caragana and Manitoba maple. A.** Adult fruittree leafroller, *Archips argyrospila* (Walker). **B.** Close-up of *A. argyrospila* damage to caragana. **C.** Mature *A. argyrospila* larva. **D.** *A. argyrospila* damage to caragana. **E.** Larger boxelder leafroller, *A. negundana* (Dyar) larva. **F.** Boxelder leafworm, *Chionodes obscurusella* (Chambers). **G.** *A. negundana* pupa. **H.** *A. negundana* damage to Manitoba maple.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THE ASPEN TWOLEAF TIER AND OTHER COMMON LEAF ROLLERS AND TIERS (Figure 81)

Distribution, Hosts, and Importance

The aspen twoleaf tier, ***Enargia decolor*** (Walker), feeds on poplar, white birch, and willow. The spotted aspen leafroller, ***Pseudosciaphila duplex*** (Walsingham), and the paleheaded aspen leafroller, ***Anacampsis niveopulvella*** (Chambers), are found mainly on trembling aspen but occasionally feed on a variety of other hardwood hosts. The aspen leafroller, ***Pseudexentera oregonana*** (Walsingham), rolls the leaves of trembling aspen and is particularly common in Alberta. The birch-aspen leafroller, ***Epinotia solandriana*** (Linnaeus), is most common on trembling aspen and white birch but is sometimes found on balsam poplar and other hardwoods. ***Epinotia criddleana*** (Kearfott) attacks trembling aspen, willow, and balsam poplar.

The threelined leafroller, ***Pandemis limitata*** (Robinson), rolls the leaves of willow, trembling aspen, white birch, and several other hardwoods. The green aspen leafroller, ***Apotomis removana*** (Kearfott) (= *dextrana* McDunnough), is found on trembling aspen, and ***A. capreana*** (Hübner) is most common on willow and white birch but also feeds on poplar. ***Ypsolopha senex*** (Walsingham) feeds on willow in Alberta, and ***Adoxophyes negundana*** (McDunnough) rolls the leaves of Manitoba maple in the southern parts of the prairie provinces.

All of the above insects occur throughout the region unless otherwise noted. Several species sometimes become locally abundant, but none are of economic importance.

Life Cycle and Appearance

Enargia decolor has one generation per year and overwinters in the egg stage. The moths are light yellow with brown markings and have a wingspan of 30–40 mm. The larvae (A) have yellowish heads, with fine white markings, and greenish white or yellowish green bodies. The white middorsal line is indistinct, but the white subdorsal line and two lateral lines are distinct. The larvae feed between two leaves tied together with silk and reach a length of 25–35 mm at maturity.

The life cycles of the remaining species are not fully understood. Those that have been studied have one generation per year. *Pseudexentera oregonana* overwinters as pupae in the duff; *Anacampsis niveopulvella, Epinotia solandriana*, and *E. criddleana* overwinter as eggs; and *Pseudosciaphila duplex* and *Pandemis limitata* spend the winter as young larvae. The adults have whitish, gray, or brownish wings, usually with darker markings, and have a wingspan of 15–25 mm. Most of the larvae are about 15 mm long when fully grown.

Pseudosciaphila duplex larvae (B) have blackish heads and whitish bodies. The thoracic shield, setal bases, a median spot on the ninth abdominal segment, and the anal plate are all blackish. ***Anacampsis niveopulvella*** larvae (C) have dark brown heads and transparent skins that reveal the food and fat bodies. The thoracic shield and anal plate are light brown, but the setal bases and paired median spots on the ninth abdominal segment are blackish. ***Pseudexentera oregonana*** larvae (D) have light-to-dark brown heads and creamy-white bodies. The thoracic shield is brown and usually has a darker brown edge.

Epinotia solandriana larvae (E) have yellowish brown heads marked with black or dark brown and have creamy colored bodies. The thoracic shield is yellow to yellowish brown, sometimes with brown edges; the anal plate is pale, and the setal bases may be the body color or light brown. ***Epinotia criddleana*** larvae (F) have yellowish brown or brown heads and yellowish green bodies. The thoracic shield is slightly darker than the body, and the large setal bases may be the body color or slightly darker. ***Pandemis limitata*** larvae (G) have yellowish green heads and bodies and reach a length of 19–23 mm at maturity. The middorsal line is bluish green with a row of pale green setal bases on each side of it.

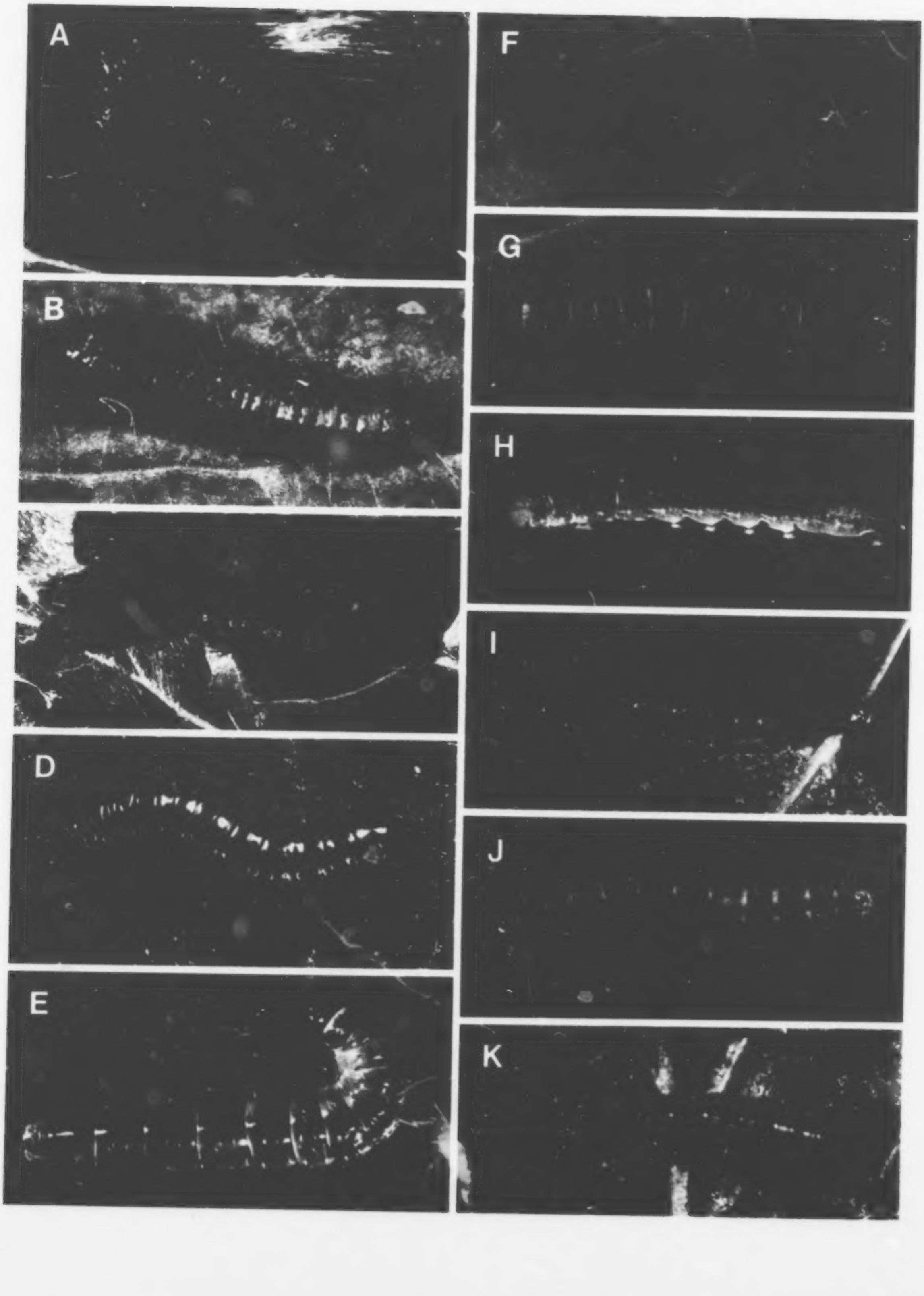
The remaining four species of larvae shown here look alike in most respects. ***Apotomis removana*** larvae (H) have yellowish green heads and transparent green bodies. ***Apotomis capreana*** larvae (I) are very similar, but the setal bases are a little more noticeable. If *Apotomis* larvae are on trembling aspen they are probably *A. removana*. ***Ypsolopha senex*** larvae (J) have green heads and green or yellowish green bodies. They resemble *P. limitata* larvae, which also feed on willow, but the middorsal line is less distinct. ***Adoxophyes negundana*** larvae (K) have yellowish green heads and bodies with inconspicuous setal bases and are found on Manitoba maple. They resemble the boxelder leafroller, *Caloptilia negundella* (Chambers) (Fig. 83) but have greener heads.

Damage

Enargia decolor occasionally causes severe localized defoliation, but recorded outbreaks have been short-lived and have caused no permanent damage to the affected trees. Several species of the leaf rollers are sometimes locally numerous. The rolled-up leaves are unsightly, especially in a park setting, but little damage is done to the trees.

Bibliography: 1, 186, 193, 215, 337, 352, 353, 354, 368, 408, 456, 458, 476, 649

Figure 81. The aspen twoleaf tier, *Enargia decolor* (Walker), and other common leaf rollers and tiers. A. *E. decolor* larva. **B.** Spotted aspen leafroller, *Pseudosciaphila duplex* (Walsingham). **C.** Paleheaded aspen leafroller, *Anacampsis niveopulvella* (Chambers). **D.** Aspen leafroller, *Pseudexentera oregonana* (Walsingham). **E.** Birch-aspen leafroller, *Epinotia solandriana* (Linnaeus). **F.** *E. criddleana* (Kearfott) larvae. **G.** Threelined leafroller, *Pandemis limitata* (Robinson). **H.** Green aspen leafroller, *Apotomis removana* (Kearfott) (= *dextrana* McDunnough). **I.** *A. capreana* (Hübner) larva. **J.** *Ypsolopha senex* (Walsingham) larva. **K.** *Adoxophyes negundana* (McDunnough) larva.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THE ASPEN WEBWORM AND ITS ALLIES (Figure 82)

Distribution, Hosts, and Importance

The aspen webworm, ***Tetralopha aplastella*** (Hulst), and the lesser aspen webworm, ***Meroptera pravella*** (Grote), feed primarily on trembling aspen but are occasionally found on other hardwoods. The birch tubemaker, ***Acrobasis betulella*** Hulst, attacks birch in Manitoba and Saskatchewan. The dusky leafroller, ***Orthotaenia undulana*** (Dyar & Shannon) (= *Badebecia urticana* Hübner), feeds on poplar, willow, birch, choke cherry, and other hardwoods. The omnivorous leafroller, ***Archips purpurana*** (Clemens), ranges west to eastern Saskatchewan on basswood, birch, trembling aspen, wild cherry, and willow. The obliquebanded leafroller, ***Choristoneura rosaceana*** (Harris), attacks poplar, birch, willow, and a wide variety of other hardwoods.

The willow leaftier, ***Nycteola frigidana*** (Walker), on willow, and the poplar leaftier, ***N. cinereana*** Neumoegen & Dyar, primarily on balsam poplar, sometimes become locally abundant. The whitetriangle tortricid, ***Clepsis persicana*** (Fitch), is found on poplar, willow, and a wide variety of other hardwoods and softwoods. ***Clepsis trileucana*** (Doubleday) was collected on trembling aspen in southern Manitoba. ***Agonopterix argillacea*** (Walsingham) feeds mainly on willow, alder, and trembling aspen. ***Choreutis diana*** (Hübner) attacks alder, white birch, balsam poplar, and willow.

All of these insects occur throughout the region unless otherwise noted, but none are of economic importance.

Life Cycle and Appearance

The life cycles are not well known for some of these insects. Most species have one generation per year. *Acrobasis betulella*, *O. undulana*, and *Choristoneura rosaceana* overwinter as young larvae; *T. aplastella* as mature larvae; *M. pravella* as pupae; and *Agonopterix argillacea* as adults. The adults are small, dull-colored moths with wingspans of 15–25 mm. The larvae web or roll leaves together and feed within the shelter thus provided. *Tetralopha aplastella* is a colonial feeder; the rest are solitary. Fully grown larvae are 15–25 mm long.

Tetralopha aplastella larvae (A) have yellowish brown heads and bodies. The head and thoracic shield have dark brown markings, and the broad subdorsal stripe is also dark brown. ***Meroptera pravella*** larvae (B) have similar markings but are much darker in color and appear to be almost black. ***Acrobasis betulella*** larvae (C) are slate gray or blackish and are unmarked except for a pale middorsal stripe on the thoracic shield. ***Orthotaenia undulana*** larvae (D) have black heads and thoracic shields and unmarked dark brown bodies.

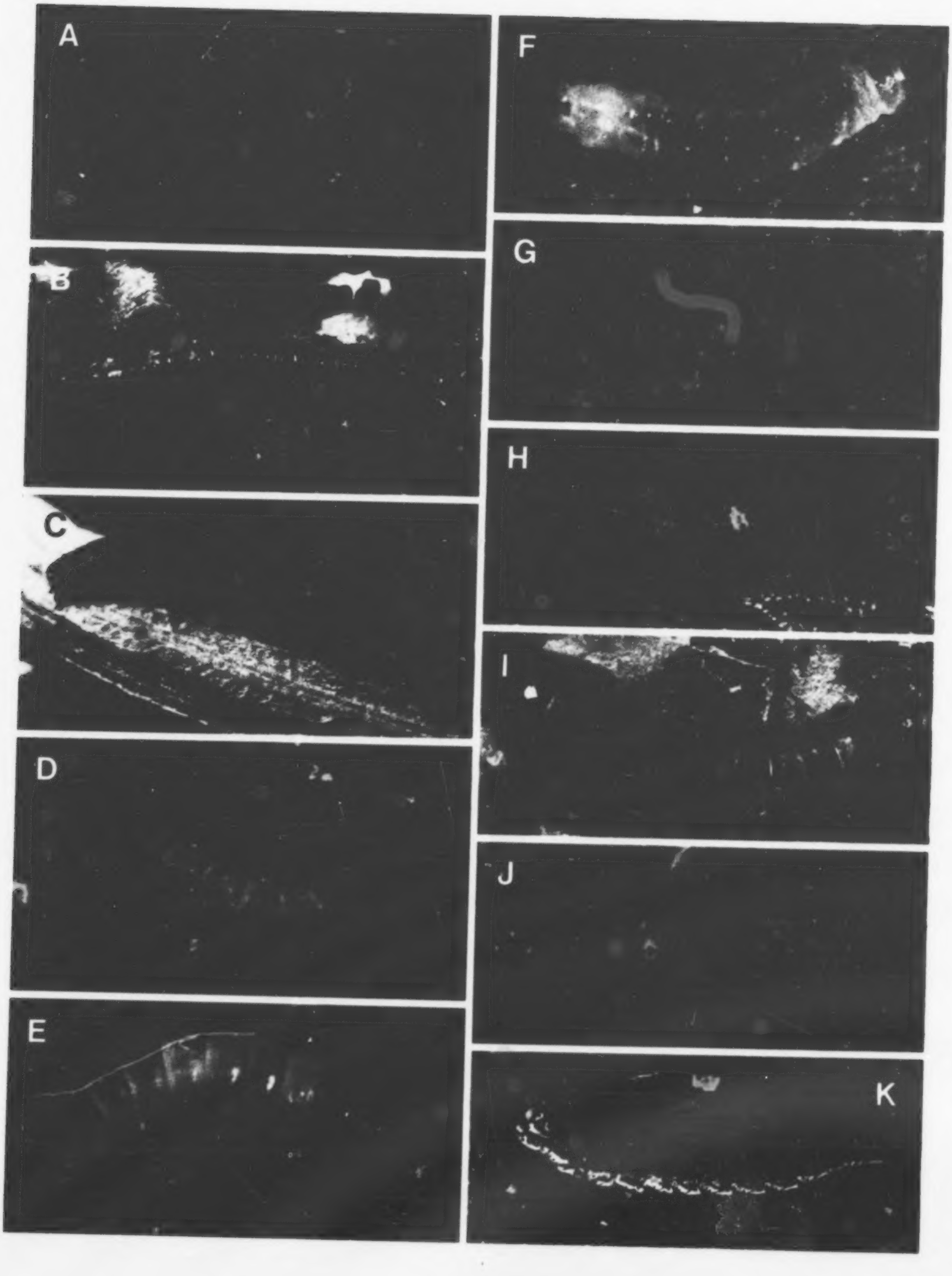
Archips purpurana larvae (E) have brown heads and light green bodies. The thoracic shield is slightly darker than the body and has a dark brown or dark green outer edge. The middorsal line is dark green and ill defined. ***Choristoneura rosaceana*** larvae (F) are extremely variable in color. Some individuals are almost identical to *A. purpurana* while others, like the one shown, have yellowish green bodies. ***Nycteola frigidana*** and ***N. cinereana*** are very similar in both their larval and adult stages but can be separated by their hosts. The front wings span about 25 mm and are light bluish gray, variably marked with black. The hind wings are whitish. The larvae are pale green with long fine hairs (G, H) and are about 25 mm long when mature. The powdery white cocoons, truncated at one end, are characteristic. ***Clepsis persicana*** larvae (not shown) have brownish yellow heads and thoracic shields. The body is slender and dark, except for the light setal bases, which give the larvae a striped appearance. ***Clepsis trileucana*** larvae (I) have yellowish green heads and bodies and are unmarked except for an indistinct dark green middorsal line. ***Agonopterix argillacea*** larvae (J) have light yellowish green heads and bodies and are also unmarked except for a green middorsal line. ***Choreutis diana*** larvae (K) have yellowish brown heads and pale green bodies with conspicuous black setal bases and black markings on the thoracic shields.

Damage

These larvae do not eat enough foliage to damage their hosts, although the webbed leaves may make ornamental trees unsightly.

Bibliography: 6, 139, 186, 193, 351, 352, 458, 476

Figure 82. The aspen webworm, *Tetralopha aplastella* (Hulst), and its allies. A. *T. aplastella* larva. **B.** The lesser aspen webworm, *Meroptera pravella* (Grote). **C.** The birch tubemaker, *Acrobasis betulella* Hulst. **D.** The dusky leafroller, *Orthotaenia undulana* (Dyar & Shannon) (= *Badebecia urticana* Hübner). **E.** The omnivorous leafroller, *Archips purpurana* (Clemens). **F.** The obliquebanded leafroller, *Choristoneura rosaceana* (Harris). **G.** The willow leaftier, *Nycteola frigidana* (Walker). **H.** The poplar leaftier, *N. cinereana* Neumoegen & Dyar. **I.** *Clepsis trileucana* (Doubleday) larva. **J.** *Agonopterix argillacea* (Walsingham) larva. **K.** *Choreutis diana* (Hübner) larva.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THE BLACKDOTTED BIRCH LEAFTIER AND ITS ALLIES (Figure 83)

Distribution, Hosts, and Importance

The blackdotted birch leaftier, ***Nites betulella*** (Busck), feeds primarily on white birch but is occasionally found on hazel and alder throughout the region. The hazel leaftier, ***N. grotella*** (Robinson), on hazel and sometimes on alder, ***Nephopterix basilaris*** Zeller, on willow and trembling aspen, and ***Antaeotricha schlaegeri*** (Zeller) and the spring oak leafroller, ***Chionodes formosella*** (Murtfeldt), on bur oak, all occur in Manitoba.

The boxelder leafroller, ***Caloptilia negundella*** (Chambers), feeds exclusively on Manitoba maple and occurs throughout the range of its host. ***Phlyctaenia coronata tertialis*** (Guenée) feeds on elder and alder and probably occurs throughout the region. The elm leaftier, ***Canarsia ulmiarrosorella*** (Clemens), is an eastern species that feeds on white elm in Manitoba. The flat leaftier, ***Psilocorsis reflexella*** Clemens, ***Salebriaria tenebrosella*** (Hulst), and ***Filatima* nr. *persicaeella*** (Murtfeldt) were each collected on bur oak in southern Manitoba. *Psilocorsis reflexella* is also reported to attack poplar, willow, and birch and to range west to central Saskatchewan.

None of these insects are of economic importance.

Life Cycle and Appearance

Most of these insects probably have one generation per year, but *Caloptilia negundella* and *Canarsia ulmiarrosorella* may have two. *Phlyctaenia coronata tertialis*, *C. ulmiarrosorella*, and *S. tenebrosella* overwinter as prepupae or pupae, but the overwintering stage for the remaining species is unknown. The adults are small, mostly dull-colored moths with wingspans of 15-20 mm, although *N. basilaris* and *A. schlaegeri* are slightly larger, with wingspans of 25 and 30 mm, respectively. The larvae usually roll or web the leaves together and feed within this shelter. Mature larvae are 15-20 mm long at maturity, depending upon the species.

Nites betulella larvae (A) have brownish green heads and bright green bodies with an indistinct darker green middorsal line. The thoracic shield is green, edged with dark brown, and the large setal bases are black. ***Nites grotella*** larvae (B) have green heads and bodies. The head is unmarked except for a black spot above each mandible. The middorsal line is slightly darker than the rest of the body, and the large setal bases are the same color as the body. ***Nephopterix basilaris*** larvae (C) have blackish heads and gray-green bodies. The thoracic shield is reddish brown with dark edges, and the upper part of the body has numerous dark gray-green stripes. ***Antaeotricha schlaegeri*** larvae (D) have brownish gray heads and thoracic shields and purplish white bodies. The head has two light brown dorsal patches outlined by curved dark brown lines. The purplish middorsal line is indistinct, and the paired brown subdorsal lines are most prominent on the thorax. ***Chionodes formosella*** larvae (E) have black heads and thoracic shields and whitish green bodies.

Caloptilia negundella adults are tiny brown moths with a wingspan of about 13 mm. The overwintering stage is not known. Young larvae at first form linear mines in the leaflets, and these abruptly become blotch mines as the larvae become larger. Half-grown larvae abandon the mines and fold over the tips of the leaflets to form tubes in which they feed until development is complete. The larvae (F) have yellowish green heads and unmarked, transparent yellowish bodies. Mature larvae are 8-10 mm long, and they spin a small, tough cocoon within the folded leaf before pupating. ***Phlyctaenia coronata tertialis*** larvae (G) are similar in appearance, but larger, and have a subdorsal black spot near the front of the second and third thoracic segments. The discontinuous darker green middorsal line is bordered by indistinct whitish lines. ***Canarsia ulmiarrosorella*** larvae (H) have green heads and bodies, with ill-defined green middorsal and subdorsal lines.

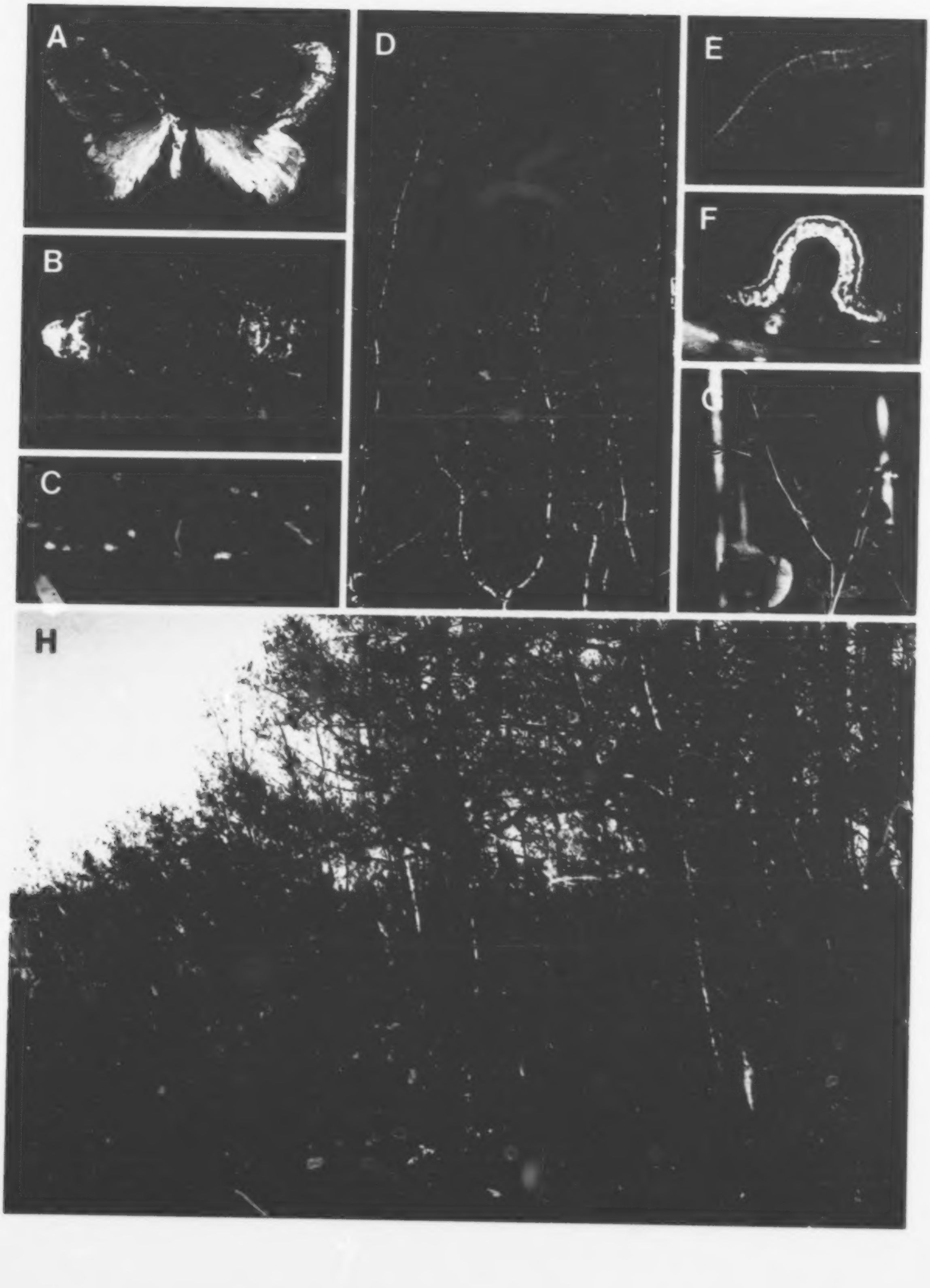
Psilocorsis reflexella larvae (I) have black heads, reddish brown thoracic shields edged in black, and pale bodies with a dark anal shield. ***Salebriaria tenebrosella*** larvae (J) have whitish green heads and bodies with black markings. The indistinct, dark middorsal line connects a series of small, irregularly shaped black dots. The subdorsal lines connect a series of conspicuous black marks. ***Filatima* nr. *persicaeella*** larvae (K) have whitish heads marked with irregular black bars. The upper part of the body is whitish with alternating black and brown lines, and the lower part of the body, including the legs and prolegs, is blackish.

Damage

Caloptilia negundella may occasionally become abundant enough to seriously damage Manitoba maple foliage, but little permanent damage to the trees is likely to occur unless the infestation persists for several years. None of the other species are abundant enough to damage their hosts.

Bibliography: 90, 134, 139, 186, 267, 458, 476

Figure 83. The blackdotted birch leaftier, *Nites betulella* (Busck), and its allies. A. *N. betulella* larva. **B.** The hazel leaftier, *N. grotella* (Robinson). **C.** *Nephopterix basilaris* Zeller larva. **D.** *Antaeotricha schlaegeri* (Zeller) larva. **E.** The spring oak leafroller, *Chionodes formosella* (Murtfeldt). **F.** The boxelder leafroller, *Caloptilia negundella* (Chambers). **G.** *Phlyctaenia coronata tertialis* (Guenée) larva. **H.** The elm leaftier, *Canarsia ulmiarrosorella* (Clemens). **I.** The flat leaftier, *Psilocorsis reflexella* Clemens. **J.** *Salebriaria tenebrosella* (Hulst) larva. **K.** *Filatima* nr. *persicaeella* (Murtfeldt) larva.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THE BRUCE SPANWORM (Figure 84)

Distribution, Hosts, and Importance

The Bruce spanworm, ***Operophtera bruceata*** (Hulst), occurs across Canada from Newfoundland to British Columbia. Its principal host in the prairie provinces is trembling aspen, but it also feeds on willow, white birch, balsam poplar, choke cherry, Manitoba maple, and white elm. Outbreaks have been reported in eastern and western Canada, including the foothills of Alberta, but none have been reported in Manitoba or Saskatchewan. Outbreaks of this insect are typically short-lived, and severe infestations seldom last more than 2 or 3 years.

Life Cycle and Appearance

Operophtera bruceata overwinters in the egg stage and has one generation per year. The eggs are deposited in bark crevices or in moss at the base of the tree trunks. They are pale green at first but soon turn bright orange (C). The larvae hatch in the spring at about the same time that the aspen foliage flushes. If the synchronization between emergence and flushing is altered by cool weather the larvae will mine the buds. The larvae (E) are stout-bodied loopers, measuring about 18 mm in length when fully grown. They are typically light green and have one prominent and two indistinct yellowish lines along each side of the body and dark brown heads. There is a large amount of color variation, however, and some individuals have blackish heads and dark gray bodies with three whitish bands or broad stripes along each side (F). The larvae may web leaves together and feed within the enclosed space, or they may feed openly, giving the foliage a ragged appearance (D, G). During severe infestations the trees may be festooned with silk (H). Larval feeding is usually finished by the 3rd week in June, and pupation occurs in thin silken cocoons spun in the leaf litter beneath the trees. Adults emerge in late fall. The males (A) are slender-bodied moths with a wingspan of 25–30 mm. The wings are a bluish gray color, with brownish markings most noticeable on the veins. The females (B) are wingless and are covered in rough scales. Some specimens are a dull ocherous brown with white patches, and others have bluish gray scales on their abdomens. The adults are very cold tolerant and may be active even when there is snow on the ground.

Damage

Outbreaks of ***O. bruceata*** seldom last long enough to cause any permanent damage to the host trees, even if defoliation is severe. There will be a loss in radial increment during an outbreak, but no mortality directly attributable to the insect is likely to occur.

Bibliography: 71, 139, 163, 164, 203, 369

Figure 84. The Bruce spanworm, *Operophtera bruceata* (Hulst). A. Adult *O. bruceata* male. **B.** Adult *O. bruceata* female. **C.** *O. bruceata* eggs in bark crevices. **D.** Trembling aspen defoliated by *O. bruceata*. **E.** *O. bruceata* larva, light color phase. **F.** *O. bruceata* larva, dark color phase. **G.** Close-up of *O. bruceata* defoliation. **H.** Trembling aspen stand heavily infested with *O. bruceata*. Silk has been spun by wandering larvae.

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CANKERWORMS (Figure 85)

Distribution, Hosts, and Importance

The fall cankerworm, ***Alsophila pometaria*** (Harris), and the spring cankerworm, ***Paleacrita vernata*** (Peck), are injurious insects on hardwoods in urban areas in the prairie provinces. Both species attack a variety of hosts, but white elm and Manitoba maple are particularly vulnerable. Other hosts commonly include basswood, bur oak, green ash, and white birch. Although the two insects often occur together in the southern part of the region, particularly in Manitoba and Saskatchewan, the fall cankerworm is usually the dominant species and probably causes the most damage.

Life Cycle and Appearance

Alsophila pometaria overwinters in the egg stage and has one generation per year. Hatching occurs in the spring at about the time of bud swelling in late May. Larval feeding begins as soon as the foliage develops and is usually completed by the end of June. Young larvae eat holes in the leaves, giving them a shot-hole appearance. Older larvae eat all of the leaves except for the larger veins and midribs (G). Larvae are slender and crawl with a looping motion. They are about 25 mm long when fully grown. They vary in color from light green (D), sometimes with white lines, to a brownish green with a darker band down the back (E). They have three pairs of prolegs, one of which is rudimentary (D), and this serves to separate them from *P. vernata* larvae (H), which have two pairs of prolegs. *Alsophila pometaria* larvae in midsummer spin tough cocoons in the soil, from which the adults emerge in late fall. The wingless females (B) are brownish gray, do not have spines, and are about 12 mm long. The males (A) are also brownish gray with irregular light bands on the front wings, which have a span of about 30 mm. The females climb the trees, mate, and lay masses of eggs high up on the trunk and branches (C).

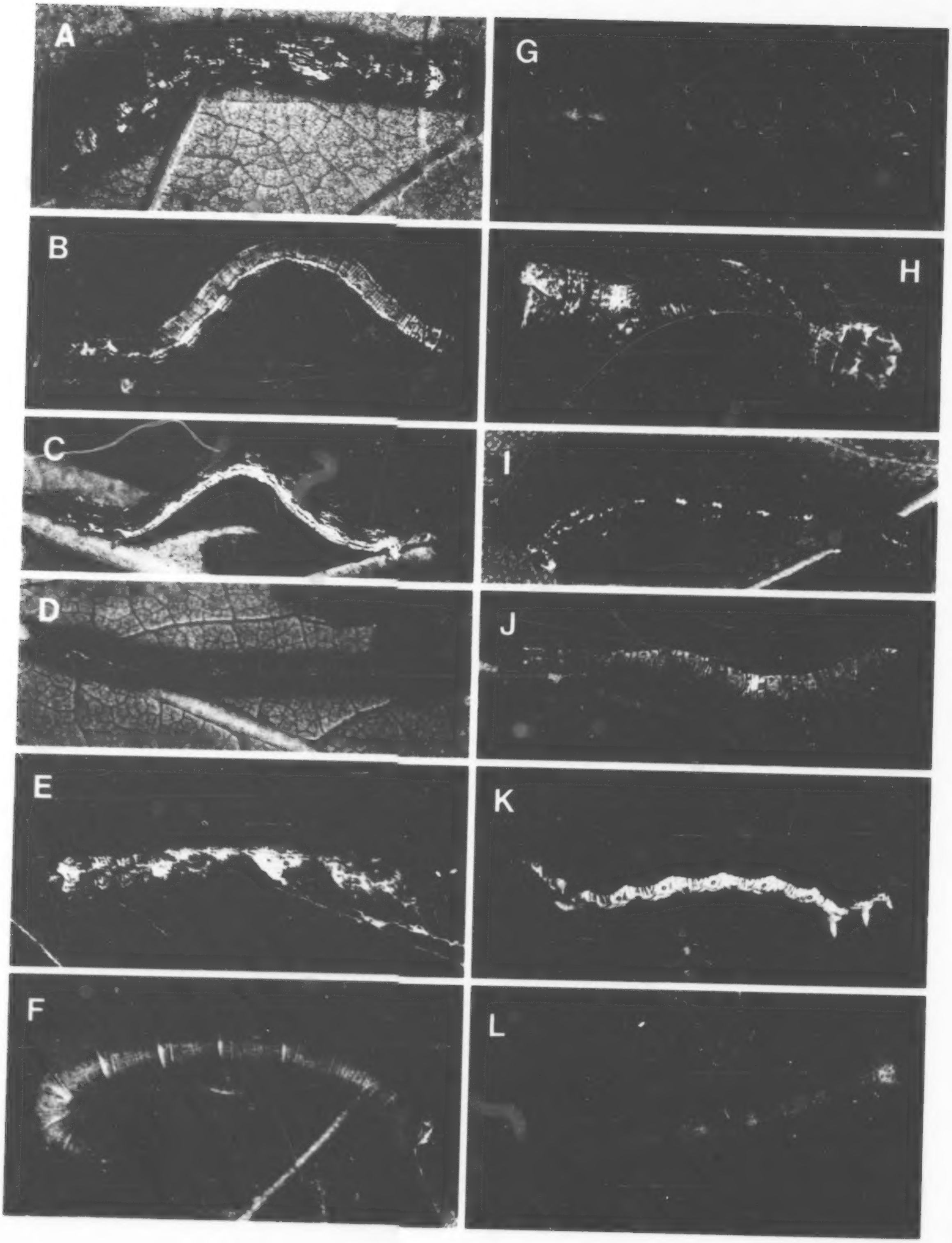
Paleacrita vernata overwinters as mature larvae in earthen cells and also has one generation per year. It pupates in very early spring within the cell. The spiny, wingless females emerge a few days later, mate, and lay eggs in clusters lower down on the trunk and branches. Larval feeding habits and seasonal development are similar to the fall cankerworm. The larvae are also slender loopers, 20-30 mm long when fully grown, and have a pair of tubercles on the dorsal surface of the abdomen near the posterior end (arrows F, H). The larvae range in color from yellowish green to almost black and may have a yellow stripe along the side of the body.

Damage

Damage by cankerworms is a result of defoliation (I). Severely defoliated trees will generally refoliate by mid-July, but repeated infestations cause a gradual weakening of the trees. Severe defoliation for 3 or more consecutive years will kill many of the upper branches, destroying the tree's aesthetic value and perhaps increasing the amount of tree mortality caused by competition from adjacent trees. In closely spaced plantings such as shelterbelts, tree mortality from this latter effect may be important.

Bibliography: 139, 203, 254, 261, 297, 300, 510, 580, 593

Figure 85. Cankerworms. A. Adult male fall cankerworm, *Alsophila pometaria* (Harris). **B.** Adult female *A. pometaria*. **C.** *A. pometaria* egg mass (eggs have hatched). **D.** Lateral view of green color phase of *A. pometaria* larva. Note rudimentary proleg at arrow. **E.** Dorsal view of dark color phase of *A. pometaria* larva. **F.** Dorsal view of spring cankerworm, *Paleacrita vernata* (Peck), larva. Note pair of tubercles at arrow. **G.** *A. pometaria* feeding damage. **H.** Lateral view of *P. vernata* larva. Note tubercle at arrow. **I.** Trees defoliated by *A. pometaria*.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THE HEMLOCK LOOPER AND ITS ALLIES ON HARDWOODS (Figure 86)

Distribution, Hosts, and Importance

The hemlock looper, ***Lambdina fiscellaria*** (Guenée), is primarily a pest of softwoods (Fig. 12), but it also feeds on white birch, trembling aspen, willow, bur oak, and elm. ***Lambdina fervidaria athasaria*** (Walker) attacks bur oak in southern Manitoba. ***Metanema determinata*** Walker attacks willow, and ***M. inatomaria*** Guenée feeds mainly on trembling aspen and balsam poplar. The elm spanworm, ***Ennomos subsignaria*** (Hübner), ranges west to Saskatchewan and feeds on white elm, basswood, white birch, and other hardwoods. ***Protitame virginalis*** (Hulst) feeds mainly on trembling aspen.

The saddleback looper, ***Ectropis crepuscularia*** (Dyar & Shannon), also feeds primarily on softwoods (Fig. 12) but is commonly found on willow, white birch, and trembling aspen. The spearmarked black moth, ***Rheumaptera hastata*** (Linnaeus), attacks birch and alder. The fringed looper, ***Campaea perlata*** (Guenée), feeds on trembling aspen, willow, white birch, and other hosts, including softwoods. The linden looper, ***Erannis tiliaria*** (Harris), feeds on basswood and a wide variety of hardwood hosts. The maple spanworm, ***Ennomos magnaria*** Guenée, attacks white birch, trembling aspen, Manitoba maple, and other hardwoods.

Unless otherwise noted, all of the above insects occur throughout the prairie provinces. Some species may occasionally become locally abundant, but none are of economic importance.

Life Cycle and Appearance

These insects probably all have one generation per year in the prairie provinces. The adults are mostly moderate in size and have wingspans of 25-40 mm, depending upon the species. They are predominantly white, gray, or shades of yellow, often with darker markings. The larvae are usually about 25-30 mm long at maturity.

Lambdina fiscellaria overwinters in the egg stage. The arvae (A, B) are variable in color, although the form shown in B) is typical. The head and body are gray or greenish gray with lack lines and spots. ***Lambdina fervidaria athasaria*** overinters in the pupal stage. The larvae (C) resemble the typical rm of *L. fiscellaria*, and some of the lateral lines are brown or ddish brown instead of black. ***Metanema determinata*** rvae (D) are slender and cylindrical. The head and body are uish gray. The latter is suffused with light brown and has distinct dorsal lines. The oblique subdorsal and lateral dark patches outline four or five lighter-colored dorsal patches. ***Metanema inatomaria*** larvae (E) are similar but lack the brown suffusion, and the rear of the abdomen is flattened. Although there is some overlap in hosts, most of the *Metanema* larvae on willow will be *M. determinata;* those on poplar are likely to be *M. inatomaria*. Both species overwinter as pupae.

Ennomos subsignaria and ***E. magnaria*** overwinter in the egg stage. The moths have wingspans of about 40 mm and 55 mm, respectively, and the larvae reach a length of about 50 mm at maturity. *Ennomos subsignaria* larvae (F) range in color from green to dark gray and have three pairs of small dorsal tubercles on their bodies. *Ennomos magnaria* larvae (L) may be yellowish green or brown. They have dorsal ridges on the second and fifth abdominal segments and a pair of dorsal tubercles on the eighth segment.

Protitame virginalis, Ectropis crepuscularia, and *R. hastata* overwinter in the pupal stage. ***Protitame virginalis*** adults have a wingspan of about 20 mm, and mature larvae are 15-20 mm long. Immature larvae (G) have greenish brown heads and green bodies with a broad purplish brown middorsal stripe. Mature larvae are light purplish brown with an indistinct darker dorsal stripe. ***Ectropis crepuscularia*** larvae (H) are brown or reddish brown at maturity. There is an inverted V-shaped suture on the face of the larvae and a pair of dorsal tubercles near the rear of the abdomen. ***Rheumaptera hastata*** larvae (I) have brown or black heads and dark brown or black bodies with reddish brown lateral spots.

Campaea perlata overwinters as a partially grown larva. The larvae (J) range in color from mottled gray to mottled brown. They have a subventral fringe of filaments along the body and a rudimentary proleg on the fifth abdominal segment. ***Erannis tiliaria*** overwinters in the egg stage. The females are wingless. The larvae (K) reach a length of about 35 mm at maturity and have light rusty brown heads and yellow bodies with numerous longitudinal wavy black lines on the dorsal half of the body. Some individuals have yellow bodies without the black lines.

Damage

None of these insects have caused any significant damage in the prairie provinces, but ***R. hastata*** has reached outbreak proportions on white birch in Alaska.

Bibliography: 139, 177, 187, 384, 388, 389, 390, 457, 476

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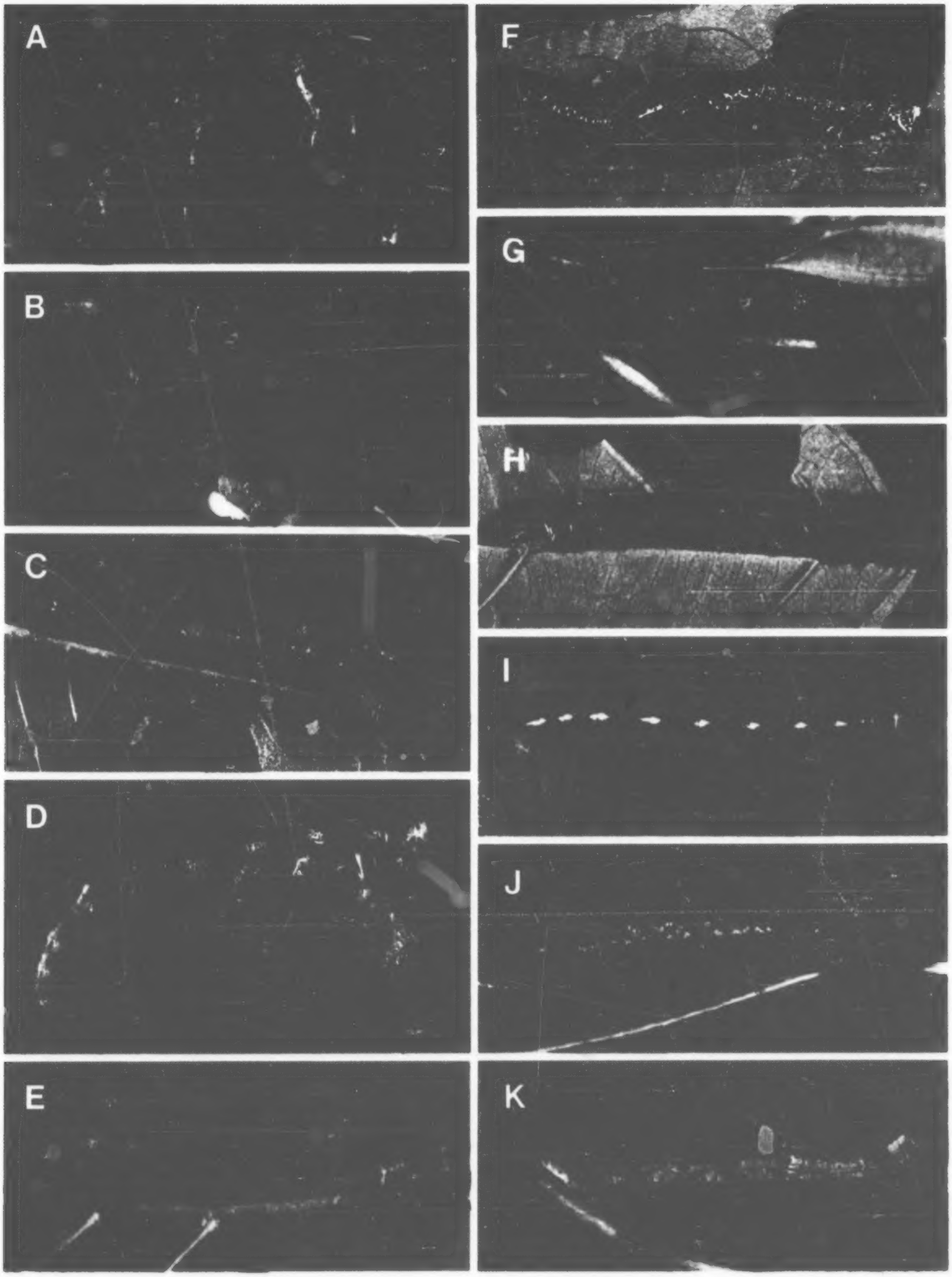
igure 86. The hemlock looper, *Lambdina fiscellaria* (Guenée), and its allies on hardwoods. A. *L. fiscellaria* larva, dark color phase. **B.** *L. fiscellaria* larva, light color phase. **C.** *L. fervidaria athasaria* (Walker) larva. **D.** *Metanema determinata* Walker larva. **E.** *M. inatomaria* Guenée larva. **F.** Elm spanworm, *Ennomos subsignaria* (Hübner). **G.** Immature *Protitame virginalis* (Hulst) larva. **H.** Saddleback looper, *Ectropis crepuscularia* (Dyar & Shannon). **I.** Spearmarked black moth, *Rheumaptera hastata* (Linnaeus),larva. **J.** Fringed looper, *Campaea perlata* (Guenée). **K.** Linden looper, *Erannis tiliaria* (Harris). **L.** Maple spanworm, *Ennomos magnaria* Guenée.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THE LARGE MAPLE SPANWORM AND OTHER MINOR LOOPERS (Figure 87)

Distribution, Hosts, and Importance

The large maple spanworm, ***Prochoerodes transversata*** (Drury), occurs as far west as central Alberta and feeds on trembling aspen, white birch, balsam poplar, willow, and a wide variety of other hosts, including softwoods. ***Besma quercivoraria*** (Guenée) is found mainly on white birch and willow. The purplish brown looper, ***Eutrapela clemataria*** (J.E. Smith), ranges west to western Saskatchewan, primarily on white birch, basswood, poplar, willow, and choke cherry. ***Plagodis alcoolaria*** (Guenée) feeds mainly on white birch, alder, and willow and occurs as far west as central Alberta. ***Plagodis phlogosaria approximaria*** Dyar attacks the above hosts, plus basswood and wild cherry.

The spiny looper, ***Phigalia titea*** (Cramer), feeds on basswood, white birch, bur oak, and other hardwoods and is found as far west as southeastern Saskatchewan. The redcheeked looper, ***Probole amicaria*** (Herrich-Schäffer), attacks a wide variety of hosts, including birch, alder, willow, and dogwood. ***Probole alienaria*** Herrich-Schäffer has been collected from white birch, basswood, hawthorn, and dogwood. The wild cherry looper, ***Lomographa semiclarata*** (Walker), feeds on pin cherry and choke cherry. ***Euchlaena marginaria*** (Minot) attacks birch, alder, elm, willow, and dogwood. ***Anavitrinelia pampinaria*** (Guenée) feeds on buffaloberry, willow, elm, birch, aspen, and other hosts, including softwoods.

All of these insects occur throughout the region unless otherwise noted, but none are of economic importance.

Life Cycle and Appearance

All of these insects overwinter in the pupal stage, and all but one have a single generation per year. The adults are white, gray, or various shades of yellow or brown, often with darker dusting or markings. Most moths have wingspans of 25–40 mm, and mature larvae are usually 25–40 mm long.

Prochoerodes transversata apparently has two generaons per year, even in the prairie provinces. The adults are raw yellow and have a wingspan of about 50 mm. The larvae A) reach a length of about 50 mm when mature and have rsal tubercles on the fourth and eighth abdominal segments. he latter are particularly prominent. The head and body of the rvae are grayish brown or barklike in color, and there is a pale tch in front of the tubercle on the fourth abdominal segment. ***esma quercivoraria*** larvae (B) have grayish heads and gray dies suffused with reddish brown markings. There is a nspicuous dorsal hump near the middle of the abdomen. ***Eutrapela clemataria*** larvae (C) are grayish and suffused with purplish brown, and they reach a length of about 60 mm when fully grown. There is a prominent dorsal hump on the second thoracic segment and prominent dorsal tubercles on the fifth and ninth abdominal segments. ***Plagodis alcoolaria*** larvae (D) have pale gray heads with brown patches. Their bodies are also pale gray and are heavily suffused with red. There are small dorsal humps on the second thoracic and eighth abdominal segments and a large dorsal hump on the fifth abdominal segment. ***Plagodis phlogosaria approximaria*** larvae (E) are very similar, but their heads have gray markings, and the reddish suffusion on their bodies is less pronounced.

Phigalia titea females are wingless. The larvae (F) have gray heads with black markings and gray bodies with orange markings and numerous longitudinal lines. There are numerous tubercles on the body. Those on the second and third abdominal segments are black and conspicuous. ***Probole amicaria*** larvae (G) vary in color from yellow or gray to dull red and have transverse dorsal humps on the second and fifth abdominal segments. The latter bears a pair of black tubercles. ***Probole alienaria*** larvae (H) are very similar, but the head is paler. Both *Probole* species may be confused with *Hypagyrtis unipunctata* (Haworth) (Fig. 90), but the latter lacks the dorsal hump on the fifth abdominal segment.

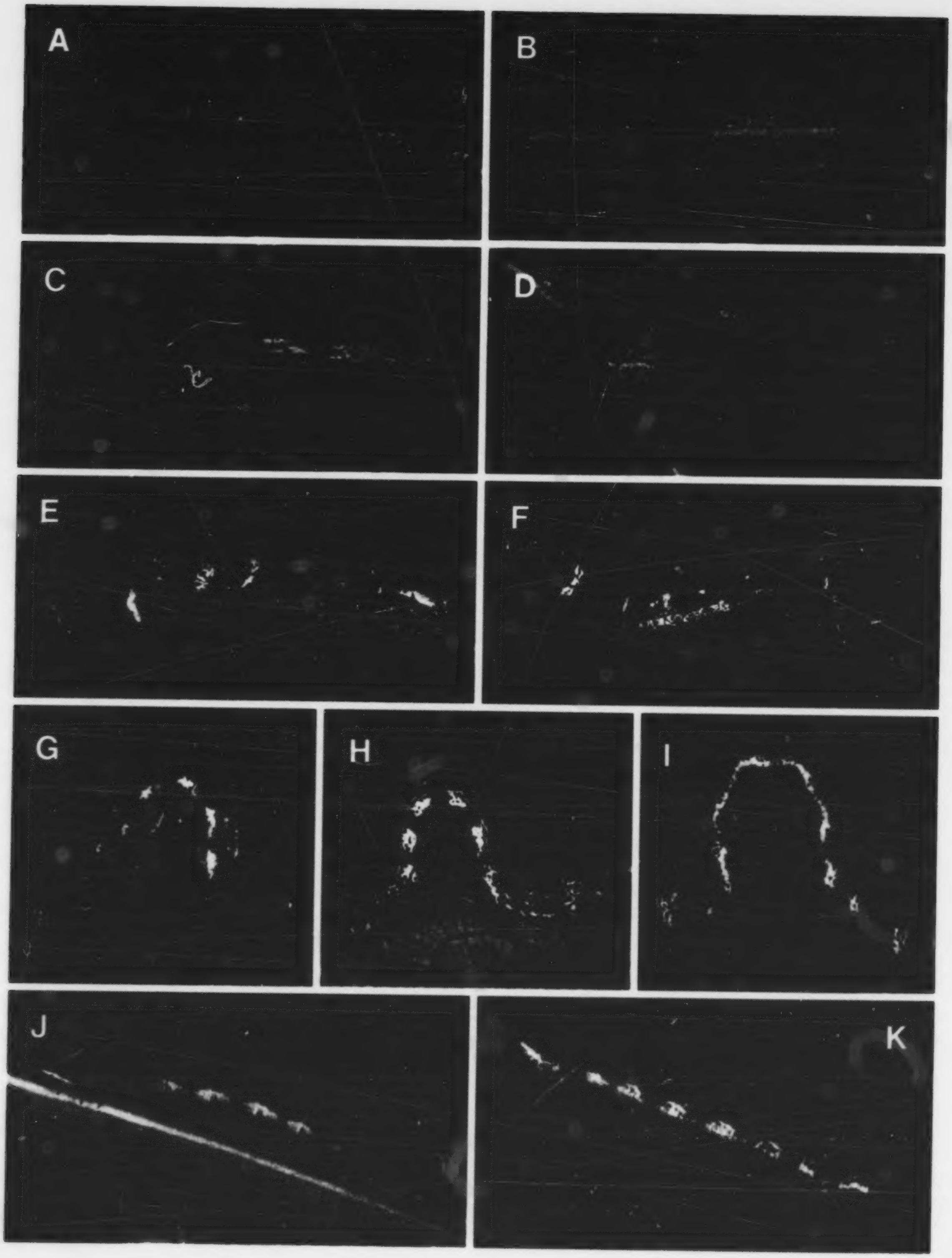
Lomographa semiclarata larvae (I) are about 20 mm long when mature. The head is green with reddish markings. The body is green with a broken yellowish middorsal line and reddish markings on the anal shield. ***Euchlaena marginaria*** larvae (J) are brownish and have elliptical tubercles on the first and fifth abdominal segments. ***Anavitrinelia pampinaria*** larvae (K) are variable in color and may be gray, green, or light brown with darker markings. The conspicuous pointed tubercle on the eighth abdominal segment separates this species from similar species, with the exception of *P. transversata* (A). The latter has tubercles on the fourth abdominal segment, with a pale patch in front of them, but the tubercles on *A. pampinaria* are on the second abdominal segment, and the pale patch is missing. *Prochoerodes transversata* larvae are also much larger when mature.

Damage

None of these loopers cause sufficient defoliation to damage their hosts.

Bibliography: 86, 139, 187, 383, 389, 390, 457

igure 87. The large maple spanworm, *Prochoerodes transversata* (Drury), and other minor loopers. A. *P. transversata* larva. **B.** *Besma quercivoraria* (Guenée) larva. **C.** Purplish brown looper, *Eutrapela clemataria* (J.E. Smith). **D.** *Plagodis alcoolaria* (Guenée) larva. **E.** *P. phlogosaria approximaria* Dyar larva. **F.** Spiny looper, *Phigalia titea* (Cramer). **G.** Redcheeked looper, *Probole amicaria* (Herrich-Schäffer). **H.** *P. alienaria* Herrich-Schäffer larva. **I.** Wild cherry looper, *Lomographa semiclarata* (Walker). **J.** *Euchlaena marginaria* (Minot) larva. **K.** *Anavitrinelia pampinaria* (Guenée) larva.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THE PEPPER-AND-SALT MOTH AND OTHER LOOPERS (Figure 88)

Distribution, Hosts, and Importance

The pepper-and-salt moth, ***Biston betularia cognataria*** (Guenée), feeds on willow, white birch, alder, aspen, and other hardwoods throughout the region. ***Pero morrisonaria*** (Hy. Edwards) also occurs throughout the prairie provinces. It is most common on softwoods but is occasionally found feeding on aspen, Manitoba maple, and other hardwoods. ***Pero honestaria*** (Walker) was collected on Canada buffaloberry in southern Alberta. The oak beauty, ***Nacophora quernaria*** (J.E. Smith), occurs west to central Saskatchewan and feeds mainly on white birch, willow, basswood, bur oak, and poplar. The twopronged looper, ***Sicya macularia*** (Harris), is found throughout the region on aspen, willow, alder, and ash.

Itame coortaria enigmata Barnes & McDunnough was collected on choke cherry in southern Manitoba. All of the following species occur throughout the region. The false Bruce spanworm, ***I. loricaria julia*** (Hulst), and ***I. exauspicata*** (Walker) feed primarily on poplar, willow, and white birch. ***Lycia rachelae*** (Hulst) attacks willow, poplar, dogwood, and other hardwoods. ***Semiothisa hebetata*** (Hulst) feeds primarily on willow, and ***S. ulsterata*** (Pearsall) attacks birch, alder, and poplar.

None of the above species are of economic importance in the prairie provinces.

Life Cycle and Appearance

All of these insects have one generation per year in the prairie provinces. The three *Itame* species, and probably *Sicya macularia*, overwinter in the egg stage; the remainder overwinter as pupae. *Biston betularia cognataria* and *N. quernaria* adults are stout-bodied moths with wingspans of about 55 mm. Both species have white wings dotted with black and suffused with brown. Adults of the remaining species have whitish, brownish, or grayish wings with darker markings and have wingspans of 25–35 mm.

Biston betularia cognataria larvae (A) reach a length of about 60 mm and may be gray, green, brown, or almost black in color, without lines. The head has reddish brown "horns", there are paired dorsal tubercles on the first thoracic and fifth abdominal segments, and there is a small dorsal hump on the eighth abdominal segment. ***Pero morrisonaria*** larvae (B) have a bilobed head and a marbled light gray body that sometimes has paired subdorsal dark lines. They reach a length of about 40 mm at maturity. ***Pero honestaria*** larvae (C) also have a bilobed head and are about 35 mm long when fully grown. The head and body are brown or gray with discontinuous dark brown middorsal, subdorsal, and lateral lines. ***Nacophora quernaria*** larvae (D) are mottled gray, have notched heads, and are 40–50 mm long at maturity. There are prominent, reddish brown dorsal tubercles on the third thoracic, second abdominal, and eighth abdominal segments and gray ventral tubercles on the third abdominal segment.

Sicya macularia larvae (E) have brown heads and reddish brown or greenish brown bodies with irregular gray transverse bands. There are unpaired dorsal tubercles on the third and fifth abdominal segments, and the larvae are about 30 mm long when mature. ***Itame coortaria enigmata*** larvae (F) have brown heads and brown bodies suffused with gray and are about 25 mm long at maturity. ***Itame loricaria julia*** females are almost wingless. The larvae (G) have brown heads and light brown to purplish bodies with darker bands and are about 20 mm long when fully grown. There is also a green color phase. ***Itame exauspicata*** larvae (H) are 20–25 mm long at maturity. The head is light gray, light green, or light brown, with black marks. The body is light green or light gray suffused with purple, and there are numerous longitudinal black lines.

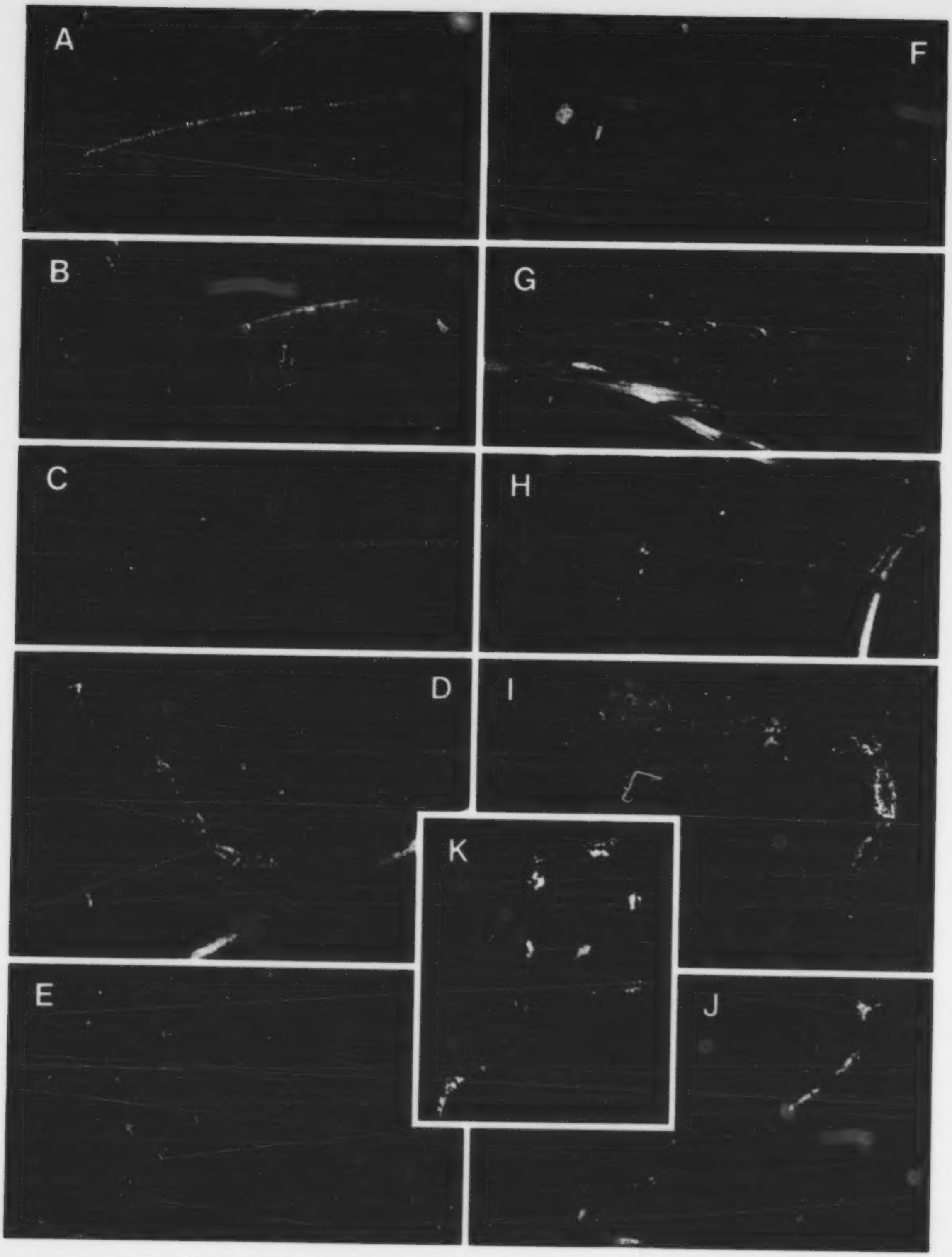
Lycia rachelae females are almost wingless, and the larvae (I) are about 40 mm long when mature. The head of the larva is whitish with brown or black marks, and the body is gray or grayish mauve. There are numerous black longitudinal lines, but these are so broken that they appear to be a series of dots. The lateral line is irregular and whitish, the spiracles are black, and the body is suffused with orange. ***Semiothisa hebetata*** larvae (J) may be green or brown and are 18–24 mm long when fully grown. The green larvae have yellowish green heads and bodies; the bodies have numerous longitudinal gray-green lines. The brown larvae (J) have yellow heads with reddish brown markings. The body is yellowish with numerous brown lines and has brown lateral patches on the second and third abdominal segments. ***Semiothisa ulsterata*** larvae (K) have reddish brown heads and light gray, green, or yellowish green bodies partially banded with reddish brown, gray, or black, especially in the dorsal area. They reach a length of 20–28 mm at maturity.

Damage

None of these insects cause enough defoliation to damage their hosts.

Bibliography: 139, 187, 388, 389, 390, 457, 476

Figure 88. The pepper-and-salt moth, *Biston betularia cognataria* (Guenée), and other loopers. A. *B. betularia cognataria* larva. **B.** *Pero morrisonaria* (Hy. Edwards) larva. **C.** *P. honestaria* (Walker) larva. **D.** Oak beauty, *Nacophora quernaria* (J.E. Smith), larva. **E.** Twopronged looper, *Sicya macularia* (Harris). **F.** *Itame coortaria enigmata* Barnes & McDunnough larva. **G.** *I. loricaria julia* (Hulst) larva. **H.** *I. exauspicata* (Walker) larva. **I.** *Lycia rachelae* (Hulst) larva. **J.** *Semiothisa hebetata* (Hulst) larva. **K.** *S. ulsterata* (Pearsall) larva.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THE TWOLINED ASPEN LOOPER AND ITS ALLIES (Figure 89)

Distribution, Hosts, and Importance

The twolined aspen looper, ***Lobophora nivigerata*** Walker, feeds on trembling aspen, willow, alder, and white birch. ***Plemyria georgii*** Hulst attacks alder, willow, birch, and dogwood. ***Hesperumia sulphuraria*** Packard feeds on willow, choke cherry, white birch, and other hosts, including softwoods. ***Hydria undulata*** (Linnaeus) defoliates willow, poplar, and alder, and ***Metarranthis duaria*** (Guenée) attacks choke cherry, saskatoon, trembling aspen, and willow. ***Eupithecia perfusca*** (Hulst) feeds on alder, willow, and birch. All of the above species occur throughout the region.

Anacamptodes ephyraria (Walker) attacks Manitoba maple, willow, green ash, and choke cherry; ***A. humaria*** (Guenée) feeds on white birch and trembling aspen. Both species range west to eastern Alberta. ***Stenoporpia polygrammaria*** (Packard) is found on bur oak in southern Manitoba and southeastern Saskatchewan. ***Cyclophora pendulinaria*** (Guenée) attacks birch, alder, and willow throughout the region. ***Synaxis jubararia*** (Hulst) feeds on willow, alder, and poplar. It is a western species whose range extends into central Alberta.

None of these insects are of economic importance in the prairie provinces.

Life Cycle and Appearance

All of these insects probably have one generation per year in the prairie provinces. The adults are small- to medium-sized moths with wingspans of 20–40 mm. They have white, yellowish, or gray wings, usually dotted or banded with a darker color. The insects overwinter in the pupal stage unless otherwise noted.

Lobophora nivigerata larvae (A) have rough, yellowish green heads. The body is grayish green or frosted green, and there is a pair of fleshy pink appendages at the end of the abdomen. The subdorsal line is white or yellow, and mature larvae are about 20 mm long. ***Plemyria georgii*** probably overwinters in the egg stage. The larvae (B) are slender and have yellowish green heads and bodies. They also have a pair of fleshy pink appendages at the end of the abdomen, but the subdorsal lines are very faint. ***Hesperumia sulphuraria*** also overwinters as an egg. The larvae (C) have light green, light gray, or light brown heads and bodies and reach a length of 18–23 mm. The head has reddish brown markings, and the body has numerous indistinct reddish or brownish dorsal and subdorsal lines. There is a pair of small tubercles on the second abdominal segment and a small dorsal hump on the eighth abdominal segment.

Hydria undulata larvae (D) are variable in color and are about 25 mm long at maturity. The head is brown, the dorsal area of the body is light brown or light purple, and the ventral area is whitish. The paired dorsal lines are whitish and indistinct, and the subdorsal lines consist of brown or purple bands extending the length of the body. ***Metarranthis duaria*** larvae (E) are brownish gray and lack any markings except for a pale, discontinuous middorsal line and a pair of white dots on the abdominal segments. They reach a length of about 30 mm.

Eupithecia perfusca larvae (F) have reddish brown heads and yellowish bodies and reach a length of about 20 mm. The middorsal line is reddish brown and ill-defined. Both *Anacamptodes* species probably overwinter as eggs. The larvae are about 25 mm long when fully grown, with dissimilar dorsal and lateral tubercles on the second abdominal segment and small dorsal tubercles on the eighth abdominal segment. ***Anacamptodes ephyraria*** larvae (G) have light brown heads with darker brown markings. The body may be gray, green, or light brown. The paired middorsal lines expand to include brownish diamond-shaped areas on most abdominal segments. ***Anacamptodes humaria*** larvae (H) have grayish green heads and gray bodies suffused with light reddish brown.

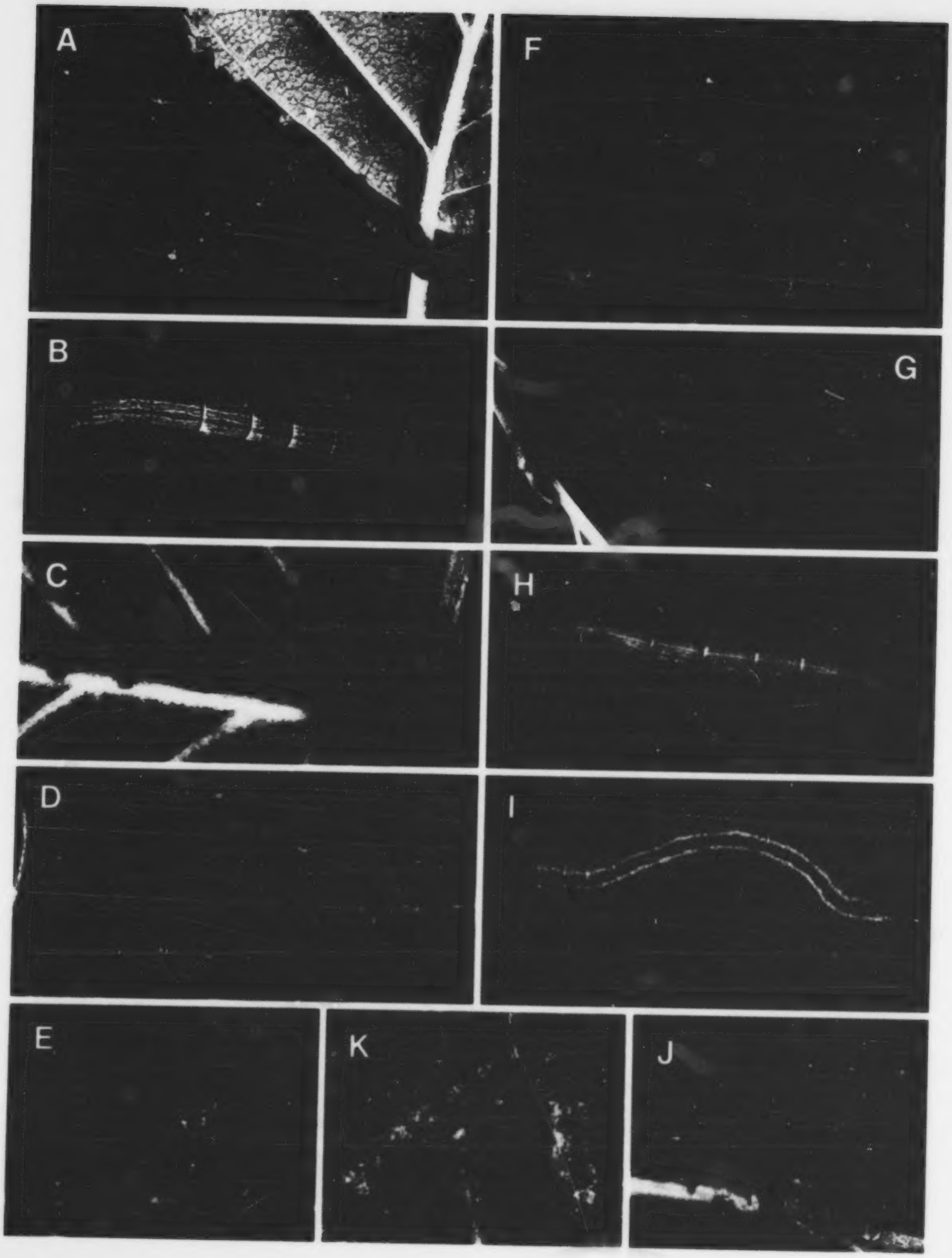
Stenoporpia polygrammaria larvae (I) reach a length of about 30 mm and have gray heads and bodies with indistinct dark gray markings. There are several small spines on most abdominal segments and a pair of dorsal tubercles on the eighth abdominal segment. ***Synaxis jubararia*** probably overwinters in the egg stage. The larvae (J) have gray heads with black markings, and the body is marbled gray and brown. There is a large dorsal hump on the second thoracic segment and dorsal tubercles on the fourth, fifth, and eighth abdominal segments. ***Cyclophora pendulinaria*** larvae (K) reach a length of 20 mm. The head is whitish or light brown with dark brown marks, and the body color may range from light brown to green. Brown larvae (K) have numerous indistinct brown or gray-brown lines on the body. There are brown and white dorsal and subdorsal patches on the anterior edges of the first five or six abdominal segments. Green larvae have yellow lines without patches.

Damage

None of these insects cause enough defoliation to damage their hosts.

Bibliography: 187, 384, 387, 389, 457

Figure 89. The twolined aspen looper, *Lobophora nivigerata* Walker, and its allies. A. *L. nivigerata* larva. **B.** *Plemyria georgii* Hulst larva. **C.** *Hesperumia sulphuraria* Packard larva. **D.** *Hydria undulata* (Linnaeus) larva. **E.** *Metarranthis duaria* (Guenée) larva. **F.** *Eupithecia perfusca* (Hulst) larva. **G.** *Anacamptodes ephyraria* (Walker) larva. **H.** *A. humaria* (Guenée) larva. **I.** *Stenoporpia polygrammaria* (Packard) larva. **J.** *Synaxis jubararia* (Hulst) larva. **K.** *Cyclophora pendulinaria* (Guenée) larva, brown color phase.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MORE MINOR LOOPERS (Figure 90)

Distribution, Hosts, and Importance

Anagoga occiduaria (Walker) occurs throughout the region and feeds on alder, birch, and willow, plus a variety of other hardwoods and softwoods. ***Aethalura intertexta*** (Walker) also occurs throughout the region and attacks alder, birch, and willow. The dotted angle of wood, ***Hypagyrtis unipunctata*** (Haworth), has been collected on dogwood and hazel in southern Manitoba. ***Cabera erythemaria*** Guenée, on willow, and ***C. variolaria*** Guenée, on willow and poplar, both occur throughout the region.

Melanolophia signataria (Walker) ranges west to Manitoba, where it feeds on white birch, willow, and a variety of other hardwoods and softwoods. The variable redmarked looper, ***M. canadaria*** (Guenée), ranges west to Saskatchewan, feeding on white birch, willow, and various other hardwoods. ***Hydriomena furcata*** (Thunberg) occurs throughout the region and attacks willow, aspen, and alder, plus other hardwoods and softwoods. ***Hydriomena transfigurata manitoba*** Barnes & McDunnough has been collected on bur oak in southern Manitoba.

None of the above insects are of economic importance in the prairie provinces.

Life Cycle and Appearance

All of these insects have one generation per year in this region and overwinter as pupae unless otherwise noted. The moths are light gray, yellow, or yellowish brown, usually with darker markings, and have a wingspan of 25–35 mm. The larvae are mostly slender and reach a length of 20–30 mm at maturity.

Anagoga occiduaria larvae (A) have pale gray heads with dark gray markings. The body is light brown and is heavily suffused with dark brown, especially in the dorsal area. There is a dorsal hump on the fifth abdominal segment. There is a row of white subdorsal dots on most abdominal segments and a conspicuous white subdorsal line on the third thoracic and first abdominal segments. Newly-molted last-instar ***Aethalura intertexta*** larvae (B) have light green heads with whitish spots and light yellow bodies with numerous light green lines. Mature larvae (C) have yellow or light gray heads heavily marked with brown and have mauve, yellow, or white bodies with numerous maroon, brown, or dark gray lines. They have a broken white subdorsal line extending the length of the body. Little is known about the life cycle of ***Hypagyrtis unipunctata*** in the prairie provinces, but they are believed to overwinter in the larval stage. Larvae collected on dogwood (D) were purplish, and those on hazel (E) were light gray with indistinct markings. The former resemble *Probole amicaria* (Herrich-Schäffer) (Fig. 87) but lack the dorsal hump on the fifth abdominal segment.

Cabera erythemaria larvae (F) have yellowish green heads and bodies. There is a reddish stripe on the side of the head and a series of deep crimson middorsal dashes on the abdomen, separating paired white patches. These are usually flanked by subdorsal and lateral rose-colored or brown patches. ***Cabera variolaria*** larvae (G) may be brown or green. The middorsal line in the brown phase consists of a series of dark gray dashes, flanked anteriorly by dark gray patches. The green phase has gray-green middorsal and lateral lines.

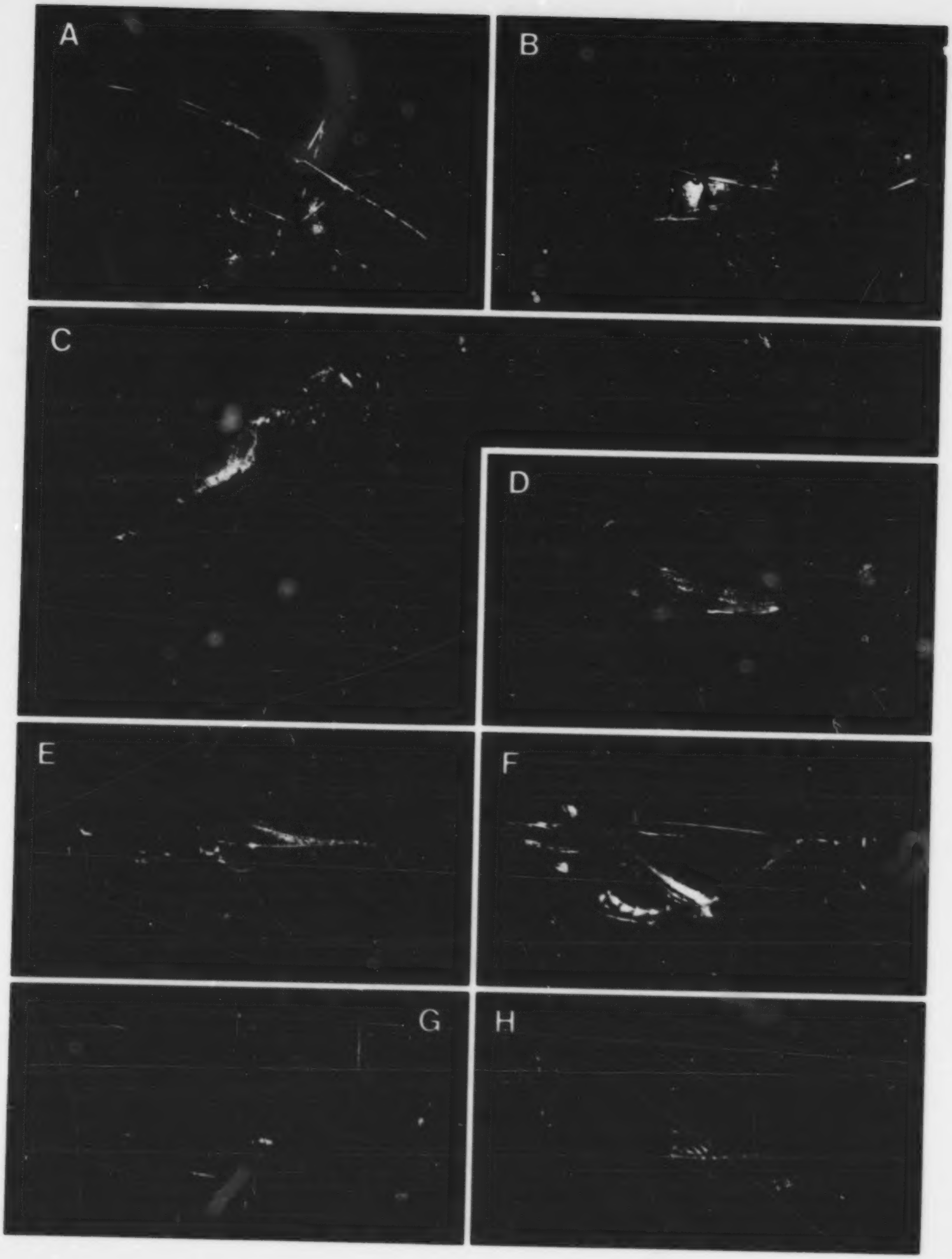
Melanolophia signataria larvae (H) have light green heads and yellowish green bodies. The middorsal line is a single stripe on the thorax and first abdominal segment that expands to enclose a series of yellow-green dashes on the next five abdominal segments. The subdorsal area has numerous fine green lines, and the lateral line is yellowish green or pink. ***Melanolophia canadaria*** larvae (I) have yellowish green or green heads and bodies. The middorsal line outlines a series of green or red ellipses on the second to sixth abdominal segments. Most of the body is covered with fine whitish lines, but the subdorsal and lateral lines are wider. The latter may be partially or completely suffused with red. *Hydriomena* larvae are relatively stout. ***Hydriomena furcata*** overwinters in the egg stage, and the larvae (J) have brown heads with black markings. The body is reddish and heavily striped with irregular black, white, and brown lines. ***Hydriomena transfigurata manitoba*** larvae (K) also have brown heads with black marks, but their bodies are light greenish brown. The middorsal line is dark and connects irregular dark dorsal patches on the first six abdominal segments, while the lateral line is brown and indistinct.

Damage

These insects are rarely abundant enough to damage their hosts.

Bibliography: 139, 187, 378, 383, 384, 386, 457, 476

Figure 90. More minor loopers. A. *Anagoga occiduaria* (Walker) larva. **B.** Newly molted *Aethalura intertexta* (Walker) larva. **C.** Mature *A. intertexta* larva. **D.** Dotted angle of wood, *Hypagyrtis unipunctata* (Haworth), larva on dogwood. **E.** *H. unipunctata* larva on hazel. **F.** *Cabera erythemaria* Guenée larva. **G.** *C. variolaria* Guenée larva. **H.** *Melanolophia signataria* (Walker) larva. **I.** Variable redmarked looper, *M. canadaria* (Guenée). **J.** *Hydriomena furcata* (Thunberg) larva. **K.** *H. transfigurata manitoba* Barnes & McDunnough larva.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THE COMMON WALKINGSTICK AND OTHER ORTHOPTERANS (Figure 91)

Distribution, Hosts, and Importance

Several species of orthopterans occur in forested areas, but few are of economic importance. The common walkingstick, ***Diapheromera femorata*** (Say), feeds on a wide variety of deciduous trees and shrubs but is most commonly found in oak stands. It has been locally abundant in southwestern Manitoba. The blackhorned tree cricket, ***Oecanthus nigricornis*** F. Walker, occurs in the southern parts of all three prairie provinces. It occasionally feeds on willow but normally occurs on herbaceous vegetation.

The broadwinged bush katydid, ***Scudderia pistillata*** Brunner von Wattenwyl, occurs on willows and other bushes in the southern parts of the region. The curvedtailed bush katydid, ***S. curvicauda*** (DeGeer), is found on various bushes in southern Manitoba, particularly in pine stands.

The twostriped grasshopper, ***Melanoplus bivittatus*** (Say), feeds mainly on forbs and occurs throughout the southern half of the region. It is one of several species of prairie grasshoppers that occur in openings in forested areas. Two other grasshoppers, ***Arphia conspersa*** Scudder, and the coralwinged grasshopper, ***Pardalophora apiculata*** (Harris), are also found in forest clearings throughout the region. They feed on grasses and sedges.

Life Cycle and Appearance

Diapheromera femorata has a 2-year life cycle. The females oviposit indiscriminately, dropping their eggs onto the litter from wherever they are resting. The rounded eggs are brown or black, with a large whitish spot. They remain in the litter for two winters and one summer. Hatching occurs in the spring of the 2nd year. The long-legged, bright green nymphs feed initially on shrubs, basswood, or cherry, but older nymphs prefer oak. Adults appear in August. They are brownish, wingless, and slender and range in length from 60 to 80 mm. The females (A) are larger and stouter than the males (B).

Oecanthus nigricornis has one generation per year and overwinters as eggs in the stems of weeds or brambles. Eggs are occasionally deposited in the twigs of elder, willow, elm, or maple. The nymphs (C) hatch in June or July and pass through five instars. They have long legs and long, slender, black antennae. Late-instar nymphs have pale bodies, and each segment bears numerous brown or black setae. The legs appear to be dark due to the numerous small black setae. Adults are about 14 mm long and resemble the nymphs but have wings. They are pale at first and become darker as they grow older. Females lay their eggs in rows in the stems of various plants, usually those with a central pith.

The life cycles of *S. pistillata* and *S. curvicauda* are not well known. Both have one generation per year and overwinter in the egg stage. The adults are green, have long legs and antennae, and are 25–30 mm long. The front wings of ***S. pistillata*** (D) are rounded and relatively broad, and those of ***S. curvicauda*** (E) are long and slender.

Melanoplus bivittatus has one generation per year and overwinters in the egg stage. Adults (F) are present from late June until September or October. Males are 27–28 mm long, and females range in length from 31 to 35 mm. The bodies of live specimens are apple green above and yellowish or greenish yellow below. A yellowish subdorsal line extends from the top of each eye, across the pronotum, and along the rear edge of each front wing, which often has a reddish patch near the tip.

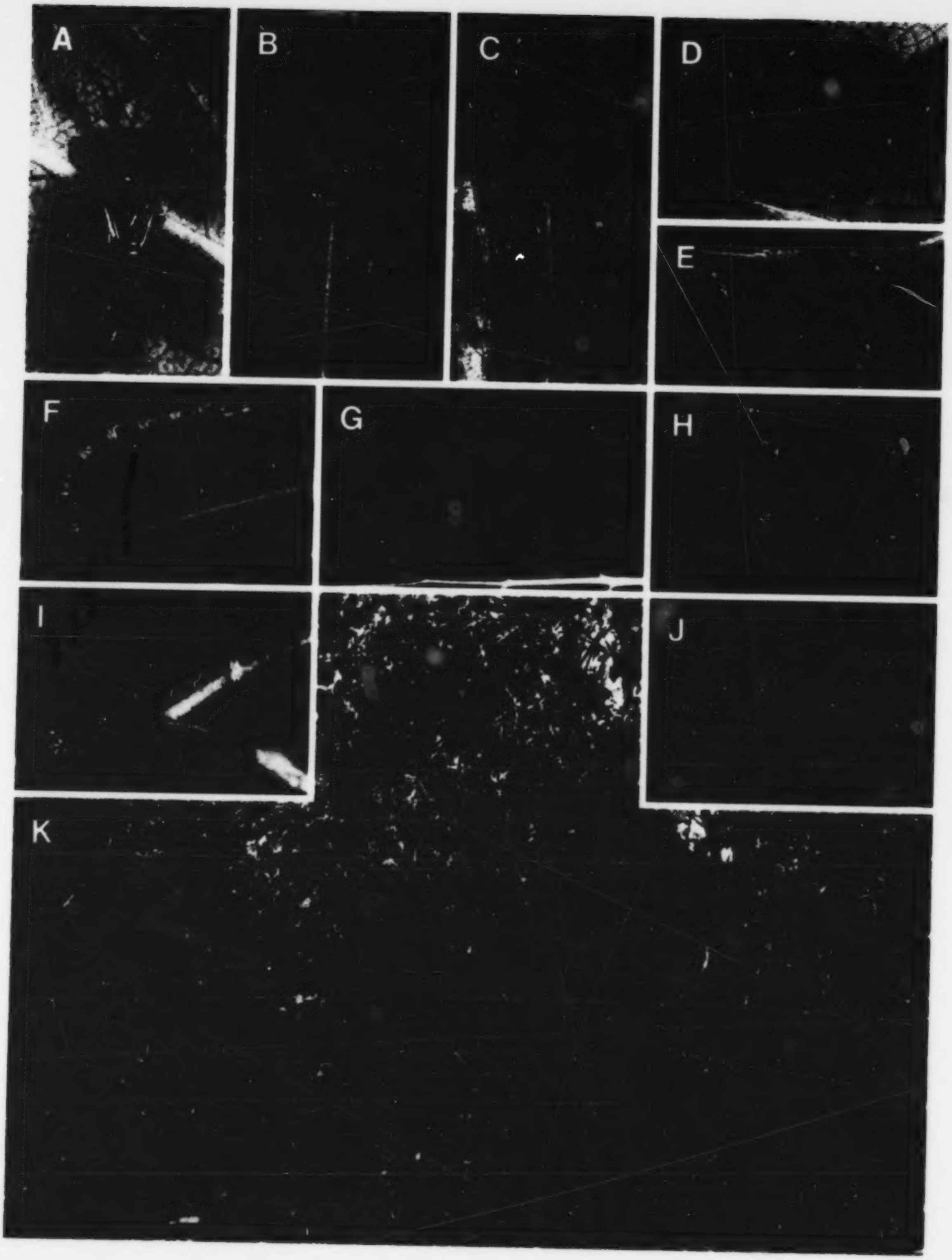
Arphia conspersa and *P. apiculata* both require 2 years to complete development. The first winter is spent in the egg stage. The eggs hatch in August, and the nymphs usually reach the fifth instar before hibernating. Activity resumes in early spring, and adults appear in early May. Oviposition occurs in June. ***Arphia conspersa*** adults (G) are light brown to brownish black. Males are 19–21 mm long, and females are 22–27 mm in length. The front wings are usually uniformly dark brown, but specimens found in wooded areas tend to have light brown front wings indistinctly dotted with black. The base of the hind wings may be red, pink, orange, or yellow, with a dark crossband. ***Pardalophora apiculata*** adults (H) are ash brown or gray. Males range in length from 30 to 36 mm, females from 40 to 46 mm. The front wings are ash brown, marked with black. The hind wings have a red base and an outer black band.

Damage

Melanoplus bivittatus and other grasshoppers have killed newly planted containerized pine seedlings. None of the other insects have caused any significant damage in the prairie provinces.

Bibliography: 33, 63, 200, 214, 219, 270, 287, 288, 429, 447, 588, 592, 618

Figure 91. The common walkingstick, *Diapheromera femorata* (Say), and other orthopterans. A. Adult female *D. femorata*. B. Adult male *D. femorata*. C. Blackhorned tree cricket, *Oecanthus nigricornis* F. Walker, nymph. D. Adult broadwinged bush katydid, *Scudderia pistillata* Brunner von Wattenwyl. E. Adult curvedtailed bush katydid, *S. curvicauda* (DeGeer). F. Adult twostriped grasshopper, *Melanoplus bivittatus* (Say). G. Adult *Arphia conspersa* Scudder. H. Adult coralwinged grasshopper, *Pardalophora apiculata* (Harris).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NEMATUS SAWFLIES (Figure 92)

Distribution, Hosts, and Importance

The genus *Nematus* contains more than 60 species of sawflies that feed on a variety of hardwood trees and shrubs. Most species are native to North America. Three of the more common species in the prairie provinces are ***N. calais*** Kirby and ***N. limbatus*** Cresson, which feed on willow, and the willow sawfly, ***N. ventralis*** Say, which feeds on willow and poplar. Other less common species are ***N. hudsoniimagnus*** Dyar on poplar, ***N. pinguidorsum*** Dyar on white birch, and ***N. salicisodoratus*** Dyar on willow. None of these insects are considered to be of economic importance, although some occasionally become abundant enough to cause severe localized defoliation.

Life Cycle and Appearance

As far as is known, most of the *Nematus* sawflies found in the prairie provinces have similar life histories, except that some species probably have one generation per year while others usually have two. All are believed to overwinter as prepupal larvae in silken cocoons spun in the duff. The male and female adults emerge in the spring or summer, depending upon the number of generations. They are stout-bodied sawflies measuring 6–9 mm in length. Fully fed larvae are 18–22 mm long. The life cycle of ***N. calais*** will be described as an example.

First-generation adults (A) emerge in June. Females deposit their eggs in slits on the underside of leaves near the ends of branches (B). Young larvae are black, and they eat the leaf tissue between the veins (C). There are five or six larval instars for both sexes. Third-instar larvae are also black but have conspicuous lateral yellow spots on most thoracic and abdominal segments (D). Older larvae eat all but the larger veins of the leaves. They have black heads and grayish bodies heavily marked with black spots. They also have a triangular black middorsal anal patch, and the lateral yellow spots are pale (E). Mature larvae spin silken cocoons in the soil or duff. Second-generation adults emerge about a week later, usually in late July or early August, and the cycle is repeated.

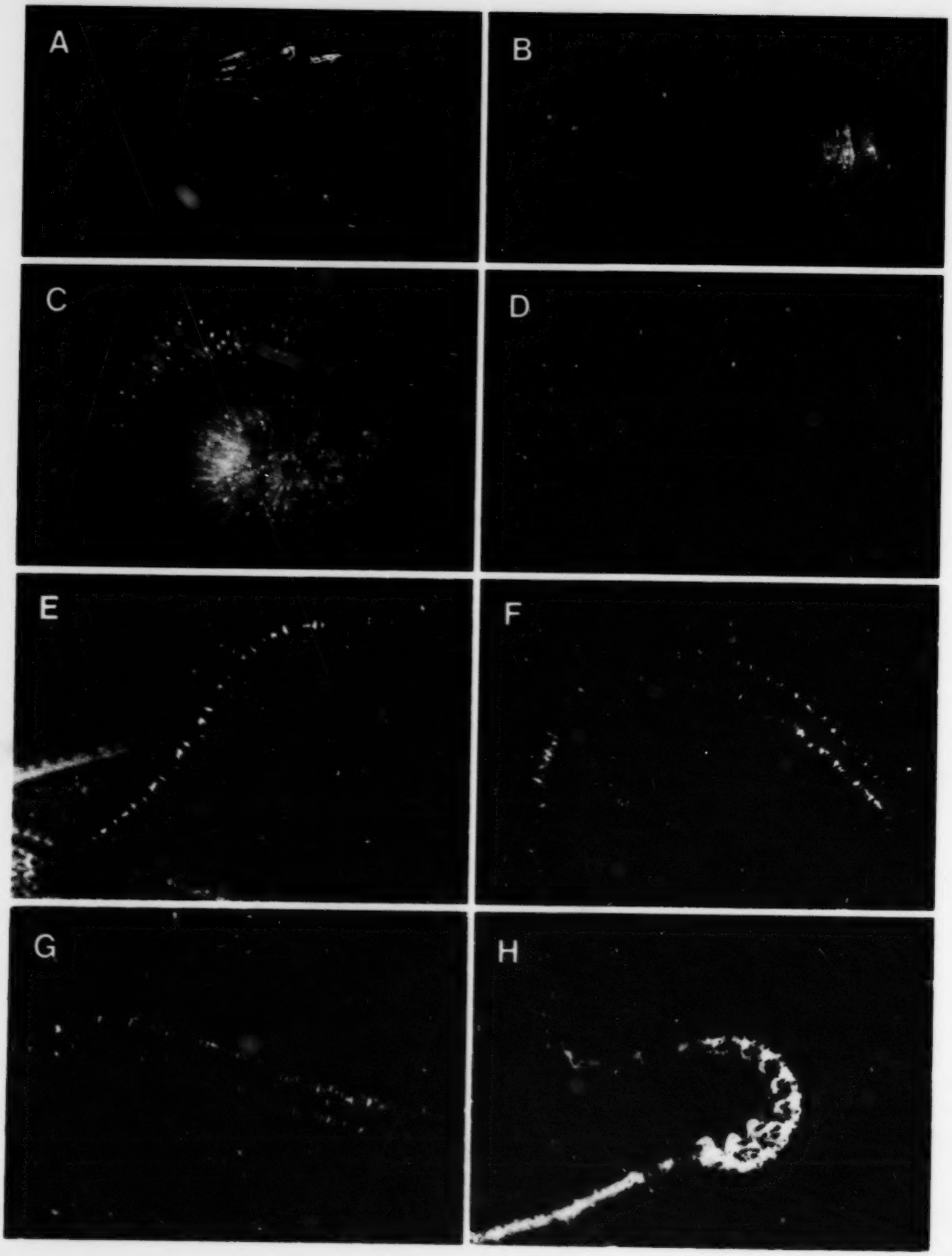
Nematus ventralis probably has two generations per year in the prairie provinces. The larvae resemble third-instar *N. calais* larvae, but the lateral yellow spots are larger (F). ***Nematus hudsoniimagnus*** is believed to have one generation per year in this region. The larvae (G) also look like third-instar *N. calais* larvae but feed on poplar. ***Nematus pinguidorsum*** has two generations per year. The larvae (H) have brownish heads and green bodies. They have a row of pale yellow subdorsal fat bodies that show through the body integument. There are numerous dark lateral dots on the body and a pink triangular middorsal anal patch. ***Nematus limbatus*** has two generations annually. The larvae (I) have black heads. Their bodies are grayish green with diffuse yellow patches and are heavily marked with black spots. ***Nematus salicisodoratus*** probably has one generation per year in the prairie provinces. The larvae (J) have black heads and yellow bodies. They can be recognized by the three rows of black dots that form almost continuous lines along their backs and by the presence of a black middorsal anal patch. The sides of their bodies are also marked with black spots.

Damage

The defoliation caused by these sawflies (K) does little permanent damage to the trees unless it is severe for several seasons. The loss of foliage is undesirable on ornamental plantings, however, because it spoils the aesthetic value.

Bibliography: 139, 362, 476

Figure 92. *Nematus* sawflies. A. Adult *N. calais* Kirby. **B.** *N. calais* egg slits on underside of a willow leaf. **C.** Second-instar *N. calais* larvae feeding on a willow leaf. **D.** Third-instar (upper) and fourth-instar (lower) *N. calais* larvae. **E.** Fifth- or sixth-instar *N. calais* larva. **F.** Willow sawfly, *N. ventralis* Say, larva. **G.** *N. hudsoniimagnus* Dyar. **H.** *N. pinguidorsum* Dyar larva. **I.** *N. limbatus* Cresson larva. **J.** *N. salicisodoratus* Dyar larva. **K.** Willow defoliated by *N. salicisodoratus* larvae.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THE ELM SAWFLY AND ITS ALLIES (Figure 93)

Distribution, Hosts, and Importance

The elm sawfly, ***Cimbex americana*** Leach, feeds primarily on elm and willow, but it also attacks white birch, trembling aspen, Manitoba maple, basswood, alder, and other hardwoods. The large willow sawfly, ***Trichiosoma triangulum*** Kirby, also attacks several hosts but is usually found on willow, white birch, trembling aspen, or alder.

The birch sawfly, ***Arge pectoralis*** (Leach), attacks birch, and ***A. cyra*** (Kirby) (erroneously referred to as *A. clavicornis* (Fabricius) in some Canadian literature) feeds primarily on white birch. ***Tenthredo* nr. *xantha*** Norton was collected on alder, and ***Rhogogaster californica*** (Norton) feeds on balsam poplar.

All of these sawflies probably occur throughout the region, but none are of economic importance.

Life Cycle and Appearance

Cimbex americana is the largest sawfly occurring in the prairie provinces. It has one generation per year and overwinters as prepupae in cocoons spun in the duff. The adults emerge in mid-June. They are heavy-bodied sawflies about 25 mm long, with a wingspan of about 40 mm. Males and females have smoky wings, knobbed black antennae, and black heads and thoraxes. Males (A) have reddish brown to purplish black abdomens. Females have black abdomens with lateral yellow spots on most segments and lay their eggs in pockets cut into the underside of the leaves. The larvae hatch in 7-10 days and have gray heads and bodies at first, but become yellowish green with a blue and black middorsal line as they grow older (B). Mature larvae (C) develop a wartlike appearance and reach a length of about 55 mm. Fully fed larvae drop from the trees to spin cocoons in late August or early September. ***Trichiosoma triangulum*** has a life history similar to *C. americana*. The larvae (D) have yellowish or brownish heads and white-spotted greenish white bodies. Cocoons are usually spun in the duff, but it is not unusual to find them securely fastened to host twigs.

Arge pectoralis has one generation per year and overwinters as prepupae in cocoons in the duff. The smoky-winged adults emerge in June and July, and the females lay their eggs in rows along the edge of the leaves. The larvae (E) are gregarious when young and are about 25 mm long when mature. They have reddish heads, yellowish green bodies bearing numerous black spots, and a black anal patch. Mature larvae drop to the ground and spin double-walled silken cocoons. The outer layer is open and lacelike, and the inner is dense and oval in shape. ***Arge cyra*** has a life cycle similar to that of *A. pectoralis*, but the larvae are solitary feeders. The larvae (F) have greenish brown heads and green bodies.

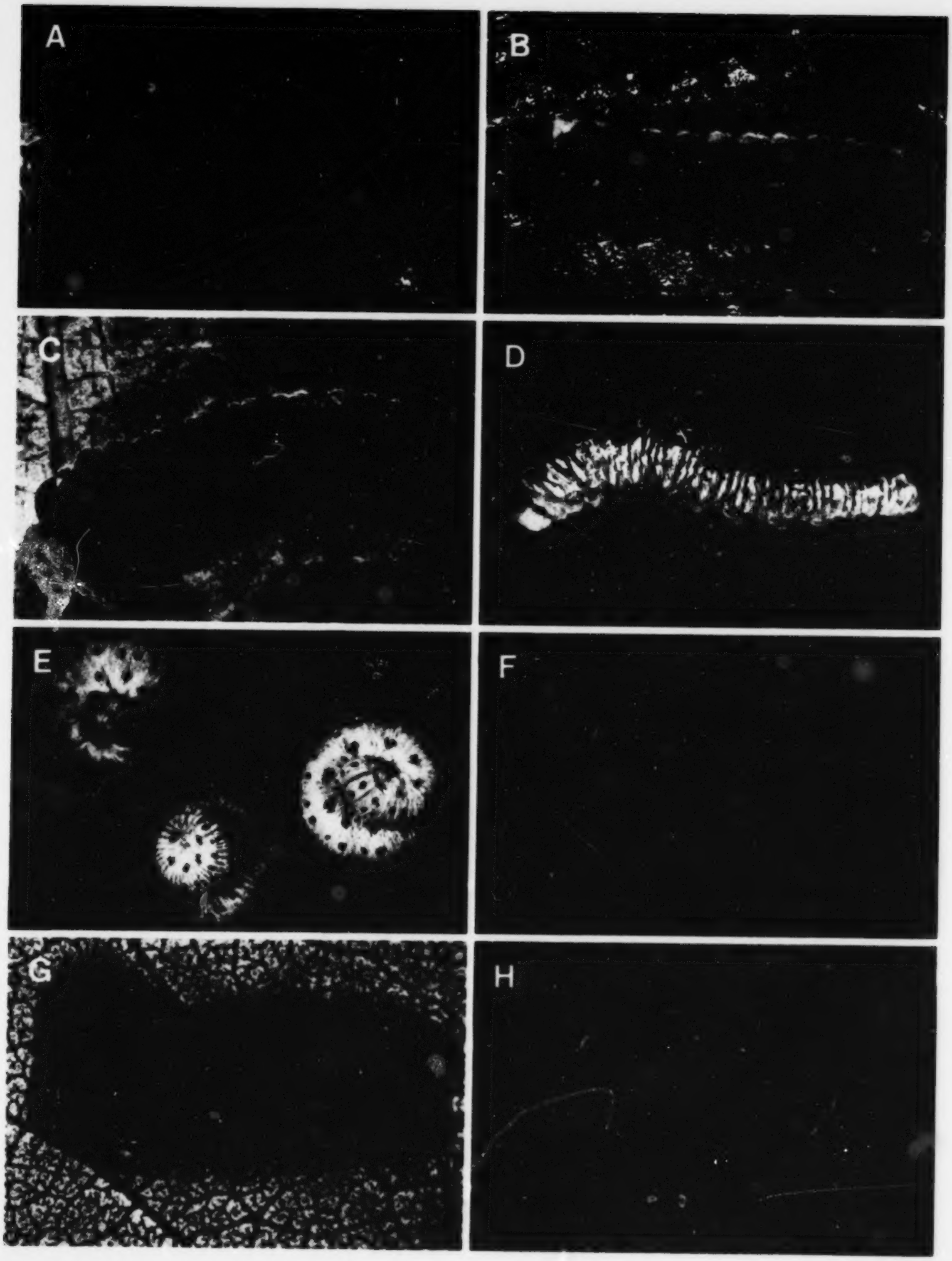
Little is known about the life cycles of *Tenthredo* nr. *xantha* or *R. californica*. Both insects are believed to have one generation per year, overwintering as prepupae in earthen cells. ***Tenthredo* nr. *xantha*** adults are about 10 mm long, are reddish with black markings, and have brownish, hyaline wings. The larvae (G) reach a length of about 15 mm when mature. They have yellowish heads and yellow bodies with indistinct paired brown middorsal lines and a brown herringbone pattern along the back, bordered laterally by a broken line of light brown spots. ***Rhogogaster californica*** adults are 8-12 mm long. Live specimens are bright green with black markings. The larvae (H) are about 20 mm long at maturity. The head is dark gray and has a vertical, tan-colored band on each side. The body is mottled dark greenish gray above and whitish below. The head and body each bear a number of short white setae.

Damage

None of these insects cause any appreciable amounts of damage, although ***C. americana*** and ***A. pectoralis*** may occasionally cause noticeable defoliation.

Bibliography: 40, 80, 139, 153, 155, 476, 487, 503, 551, 562, 657

Figure 93. The elm sawfly, *Cimbex americana* Leach, and its allies. **A.** Adult male *C. americana*. **B.** Young *C. americana* larva. **C.** Mature *C. americana* larva in resting position. **D.** Large willow sawfly, *Trichiosoma triangulum* Kirby, larva in resting position. **E.** Birch sawfly, *Arge pectoralis* (Leach), larva. **F.** *A. cyra* (Kirby) larva. **G.** *Tenthredo* nr. *xantha* Norton larva. **H.** *Rhogogaster californica* (Norton) larva.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MINOR SAWFLY SPECIES ON HARDWOODS (Figure 94)

Distribution, Hosts, and Importance

Several minor sawfly species attack various hardwoods in the prairie provinces. ***Nematinus unicolor*** (Dyar) feeds exclusively on birch. ***Priophorus pallipes*** (Lepeletier) attacks birch, alder, willow, and cherry. ***Empria improba*** (Cresson) feeds on willow. The woolly alder sawfly, ***Eriocampa ovata*** (Linnaeus), is an introduced species that has been collected on alder in Alberta.

The dogwood sawfly, ***Macremphytus tarsatus*** (Say), and ***M. testaceus*** (Norton) both feed on dogwood. ***Fallocampus americanus*** (Marlatt) and ***F. albostigmus*** (Rohwer) are commonly found feeding on trembling aspen. The cherry webspinning sawfly, ***Neurotoma fasciata*** (Norton), feeds on wild cherry in Manitoba.

All of these sawflies probably occur throughout the region unless otherwise noted, but none are of economic importance.

Life Cycle and Appearance

The life cycles of these sawflies have not been studied in the prairie provinces. All are believed to overwinter as prepupae, and most have one generation per year. ***Eriocampa ovata*** sometimes has a partial second generation. Similarly, most species spin cocoons in the soil, duff, or wood, but ***N. fasciata*** overwinters in earthen cells. The adults are small- to medium-sized, nondescript sawflies.

Nematinus unicolor larvae (A) have brown heads with black eye spots and have two subdorsal blackish marks on the back of the head. The body is a translucent light green and tapers slightly towards the rear. The thorax is flattened ventrally but not greatly widened, and the food in the gut shows through the body wall. Mature larvae are about 18 mm long. ***Priophorus pallipes*** larvae (B) are about 16 mm long when mature and have brown heads marked with light spots. The body is pale ventrally and brownish gray dorsally. The setal bases and anal segment are pale. ***Empria improba*** larvae (C) have grayish brown heads that are subdorsally lighter in color at the back. The body is pale ventrally and dark gray dorsally. There are four longitudinal rows of small, pale, dorsal tubercles and numerous transverse rows of pale granulations. Mature larvae are about 18 mm long.

Eriocampa ovata larvae (D) have grayish heads and pale green bodies, but both the head and body are covered with a white, waxy flocculence except in the last instar and just after each molt. Mature larvae are about 16 mm long. ***Macremphytus tarsatus*** larvae (not shown) have black heads. Their bodies are black with yellow transverse bars dorsally and are solid yellow ventrally. Their heads and bodies are usually covered with a white flocculence, except during the last instar and immediately following each molt. Mature larvae are about 22 mm long. ***Macremphytus testaceus*** larvae (E, F) have black heads and yellow bodies with subdorsal and lateral rows of black dots. They are also covered with a white flocculence, and they typically rest in a tightly coiled position with the rear of the body slightly elevated (E). Mature larvae are about 22 mm long.

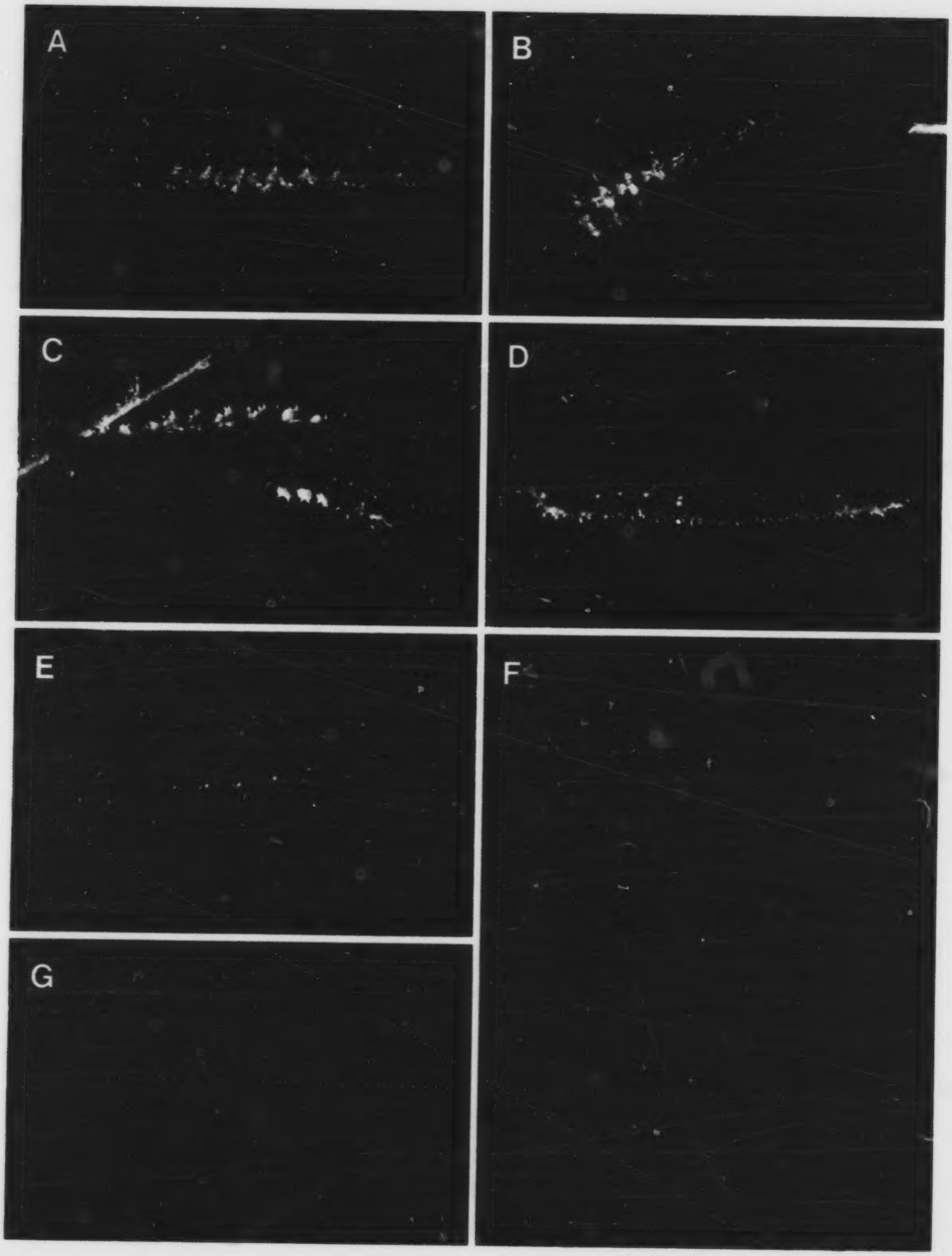
Fallocampus americanus larvae (G) have greenish black heads. Their bodies are greenish black dorsally, with pale setal bases, and are pale ventrally. The thorax is enlarged and flattened ventrally, giving the larvae a superficial resemblance to tadpoles. The larvae rest in a curled position and are about 18 mm long at maturity. ***Fallocampus albostigmus*** larvae (H) have light brown heads, and the top of the head is slightly darker. The body is a translucent greenish yellow, and the gut contents are visible through the integument. The thorax is enlarged and flattened ventrally, and the second thoracic segment bears a pair of dark subdorsal spots. ***Neurotoma fasciata*** larvae (not shown) have dark brown or brownish black heads and unmarked pale green bodies. They have conspicuous antennae and subanal appendages and resemble pamphiliid larvae on conifers (Fig. 18) except for coloration. The larvae are gregarious and web foliage together to form unsightly nests. Mature larvae are about 22 mm long.

Damage

None of these larvae damage their hosts, although the unsightly nests of ***N. fasciatus*** would be objectionable on ornamental plantings of Schubert choke cherry.

Bibliography: 139, 157, 357, 401, 402, 476, 485, 632, 639, 657

Figure 94. Miscellaneous sawflies on hardwoods. A. *Nematinus unicolor* (Dyar) larva. **B.** *Priophorus pallipes* (Lepeletier) larva. **C.** *Empria improba* (Cresson) larva. **D.** Woolly alder sawfly, *Eriocampa ovata* (Linnaeus), larva. **E.** *Macremphytus testaceus* (Norton) larvae in resting position. **F.** *M. testaceus* larva. **G.** *Fallocampus americanus* (Marlatt) larva. **H.** *F. albostigmus* (Rohwer) larva.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HAIRY OR SPINY SAWFLY LARVAE ON HARDWOODS (Figure 95)

Distribution, Hosts, and Importance

The larvae of several genera of hardwood-feeding sawflies are hairy or spiny. The following are examples of hairy sawflies that occur throughout the region: the hairy poplar sawfly, ***Trichiocampus viminalis*** (Fallen), a Holarctic species that feeds on poplar and sometimes willow; ***T. gregarius*** (Dyar), a species that feeds on poplar; and the hairy willow sawfly, ***T. simplicornis*** (Norton), a species that feeds on willow.

Spiny larvae occur in three genera. ***Dimorphopteryx abnormis*** Rohwer feeds on wild plum, choke cherry, and saskatoon, and the fringed birch sawfly, ***D. melanognathus*** Rohwer, feeds on birch. The spiny ash sawfly, ***Eupareophora parca*** (Cresson), attacks ash. All three species range west to Saskatchewan. Another spiny sawfly, ***Periclista albicollis*** (Norton), feeds on bur oak in Manitoba.

None of these sawflies are of economic importance in the prairie provinces.

Life Cycle and Appearance

Trichiocampus viminalis has one complete generation annually plus a partial second generation during warm summers. Winter is passed as prepupae in cocoons in the soil. The adults are 5–7 mm long and are black with orange legs and orange markings on the thorax and abdomen. The larvae (not shown) are about 20 mm long when mature. The head is black, and the body is yellowish and has subdorsal and lateral rows of black spots. Several simple white hairs arise from each of several small tubercles on each body segment. The larvae feed gregariously when young but tend to scatter as they mature.

The life histories of the remaining species discussed here are not well known. All are believed to have one generation per year and to overwinter as prepupae in cocoons in the soil. Adults emerge during the spring, and larvae are present until late summer. ***Trichiocampus gregarius*** larvae (A) are very similar to those of *T. viminalis* but have a third row of small black dots above the abdominal prolegs. ***Trichiocampus simplicornis*** larvae (B) have black heads and yellowish bodies with subdorsal and lateral rows of black dots. They are almost identical to those of *T. viminalis*, but the latter are not usually found on willow.

All species of ***Dimorphopteryx*** larvae (C, D) have a number of features in common. Their heads are higher than wide, and their bodies are flattened and sluglike, with the extended lateral folds of the body bearing a number of fleshy tubercles. The first thoracic segment bears a pair of prominent middorsal tubercles. There are also subdorsal and lateral rows of small, pale tubercles extending the length of the body. The subdorsal tubercles on the ninth abdominal segment are large, and those on the tenth segment form apical spines. ***Dimorphopteryx abnormis*** larvae (C) have reddish brown heads that are darker in the dorsal area and have reddish brown bodies with pale lateral folds. ***Dimorphopteryx melanognathus*** larvae (D) have brown heads that are darker in the dorsal area and have grayish green bodies with pale lateral folds.

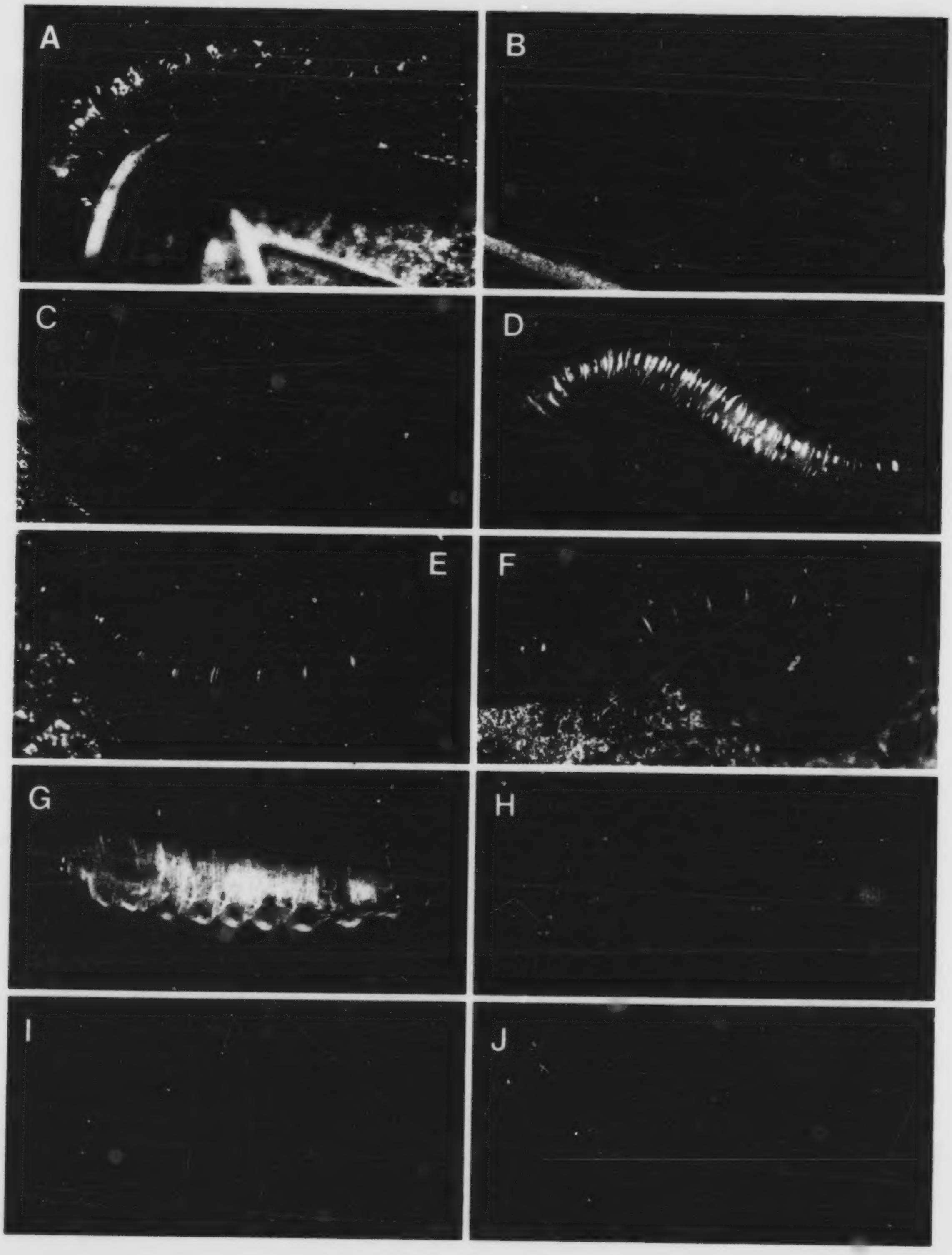
The larvae of ***E. parca*** (E, F) and ***P. albicollis*** (G) have shining black heads and several rows of mostly bifurcate spines on their bodies. They reach a length of about 20 mm when mature. *Eupareophora parca* larvae are gregarious, have yellowish bodies, and feed only on ash; *P. albicollis* larvae are usually solitary feeders, have light green or grayish bodies, and feed only on oak.

Damage

None of these sawflies have damaged their hosts in the prairie provinces.

Bibliography 30, 139, 158, 404, 476, 528, 544, 657

Figure 95. Hairy or spiny sawfly larvae on hardwoods. A. *Trichiocampus gregarius* (Dyar) larva. **B.** Hairy willow sawfly, *T. simplicornis* (Norton), larva. **C.** *Dimorphopteryx abnormis* Rohwer larva. **D.** Fringed birch sawfly, *D. melanognathus* Rohwer, larva. **E.** Spiny ash sawfly, *Eupareophora parca* (Cresson) larva. **F.** Group of *E. parca* larvae. **G.** *Periclista albicollis* (Norton) larva.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THE DUSKY BIRCH SAWFLY AND ITS ALLIES (Figure 96)

Distribution, Hosts, and Importance

The dusky birch sawfly, ***Croesus latitarsus*** Norton, feeds on various species of birch. The striped alder sawfly, ***Hemichroa crocea*** (Geoffroy), is a Holarctic species that feeds primarily on alder but is occasionally found on birch and willow.

Several species of sawflies in the genus *Pristiphora* feed on various hardwoods. ***Pristiphora sycophanta*** Walsh feeds on willow, and the mountain-ash sawfly, ***P. geniculata*** (Hartig), an introduced species now present in southeastern Manitoba, attacks native and introduced mountain-ash species. Other *Pristiphora* species include ***P. siskiyouensis*** Marlatt on birch, ***P. chlorea*** (Norton) on bur oak in southern Manitoba, and ***P. acidovalva*** Wong on willow.

The blackheaded ash sawfly, ***Tethida cordigera*** (Beauvois), feeds on ash in Manitoba. The brownheaded ash sawfly, ***Tomostethus multicinctus*** (Rohwer), also attacks ash. It probably occurs in southeastern Manitoba, but this has not been confirmed. The sawfly genus *Amauronematus* contains a number of species that are common in the region, but the group needs revision. Three examples are ***A. nr. neglectus*** (Kirby) on alder, ***A. nr. orbitalis*** Marlatt on white birch, and ***A. nr. lineatus*** (Harrington) on willow.

All of these sawflies occur throughout the region unless otherwise noted, but none are currently of economic importance. ***Pristiphora geniculata***, however, may eventually become a serious pest of ornamental plantings of mountain-ash in our area.

Life Cycle and Appearance

Adults of these medium-sized sawflies are nondescript brown or black insects that are difficult for anyone but an expert to identify. *Croesus latitarsus* and *H. crocea* probably have a partial second generation in the prairie provinces, overwintering as prepupae in cocoons in the soil. ***Croesus latitarsus*** larvae (A) have black heads and yellowish green bodies with a subdorsal row of black blotches and double lateral rows of elongated black dots. Mature larvae are about 24 mm long. ***Hemichroa crocea*** larvae (B) have black heads and yellowish bodies and reach a length of about 20 mm. A dark brown or black subdorsal line extends the length of the body, and a double, lateral row of blotches and dashes extends to the ninth abdominal segment. The dorsal rear edge of the last abdominal segment is black with a row of tubercles.

The remainder of the species discussed here probably have one generation per year, with the exception of *P. geniculata* and *P. siskiyouensis*, which have a second or partial second generation. The larvae are about 12–13 mm long when mature, and they overwinter in cocoons in the soil. ***Pristiphora sycophanta*** larvae (C) have yellowish white heads with black eyes and pale green bodies. The paired middorsal lines are whitish, and the anal segment is pinkish. ***Pristiphora geniculata*** larvae have dark brown or black heads and thoracic legs during the first three larval instars. Their bodies are pale green or yellow with black spots. Mature larvae (D) (fourth-instar males and fifth-instar females) have yellow heads, yellow thoracic legs, and yellow bodies with black spots. ***Pristiphora siskiyouensis*** larvae (E) have green heads with dusky markings and unmarked green bodies with three yellow-green lines (fat bodies) on posterior segments. ***Pristipora chlorea*** larvae (F) have green heads with black eyes and green bodies. ***Pristiphora acidovalva*** larvae (not shown) have pale heads with a dark brown face and brown dots on the rest of the head. The body is light green with brown spots on all of the body except for the dorsal area of the abdomen.

Tethida cordigera and *Tomostethus multicinctus* overwinter as larvae in silk-lined earthen cells. ***Tethida cordigera*** larvae (G) have black heads and whitish bodies tinged with yellow and are about 18 mm long when mature. ***Tomostethus multicinctus*** larvae (not shown) are greenish or yellowish white and have brown heads. They reach a length of 15–20 mm.

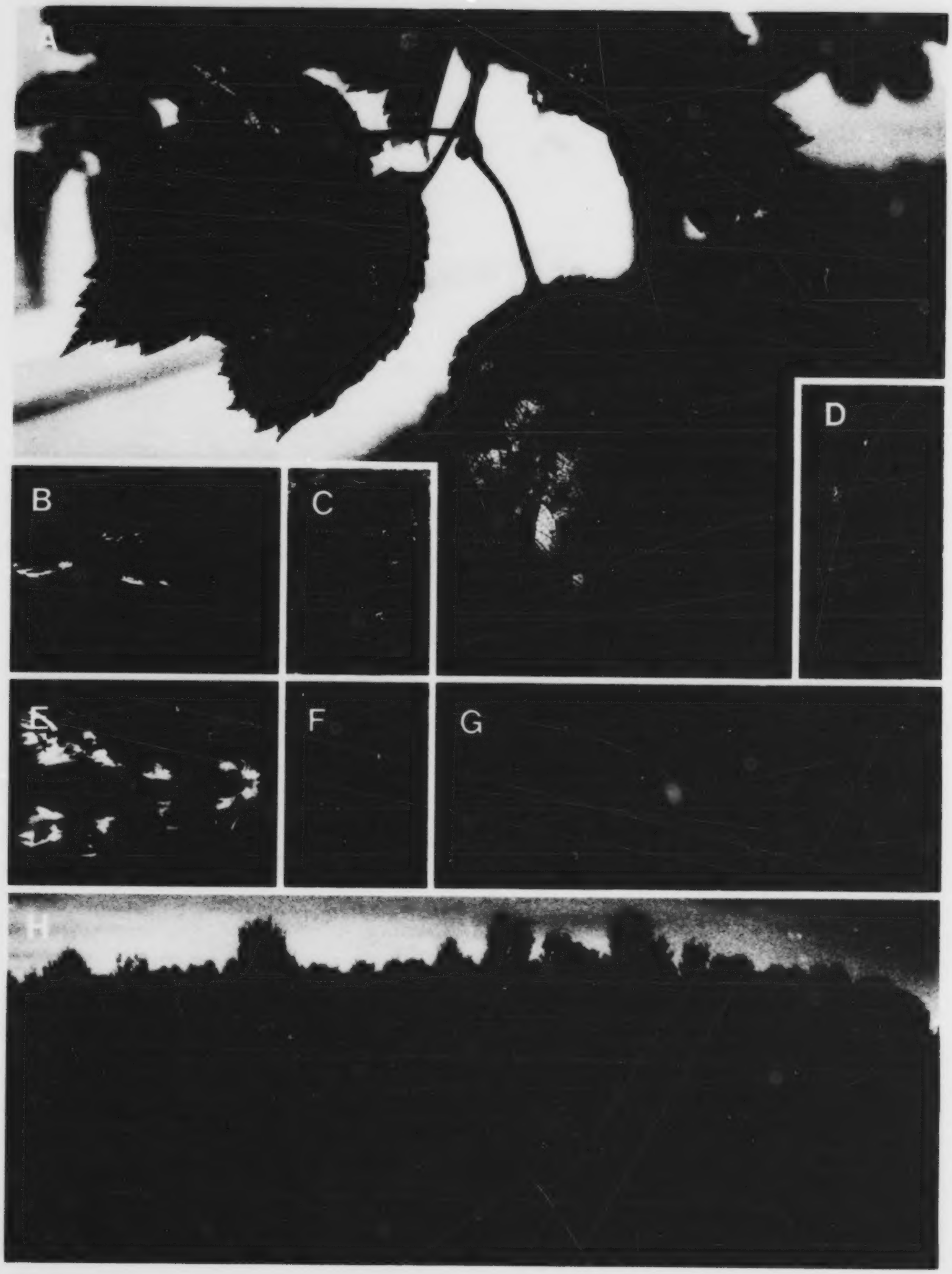
The various *Amauronematus* species overwinter as larvae in cocoons. The larvae of ***A. nr. neglectus*** (H) are greenish white, those of ***A. nr. orbitalis*** (I) are green, and those of ***A. nr. lineatus*** (J) are whitish green with indistinct subdorsal and lateral white lines. *Amauronematus* nr. *lineatus* larvae also have a pair of small caudal protuberances.

Damage

All of these larvae defoliate their hosts but seldom cause any tree mortality.

Bibliography: 139, 152, 154, 156, 158, 185, 273, 328, 339, 405, 476, 484, 527, 529, 632, 635, 657

Figure 96. The dusky birch sawfly, *Croesus latitarsus* Norton, and its allies. **A.** *C. latitarsus* larva. **B.** Striped alder sawfly, *Hemichroa crocea* (Geoffroy), larva. **C.** *Pristiphora sycophanta* Walsh larva. **D.** Mountain-ash sawfly, *P. geniculata* (Hartig), larva. **E.** *P. siskiyouensis* Marlatt larva. **F.** *P. chlorea* (Norton) larva. **G.** Blackheaded ash sawfly, *Tethida cordigera* (Beauvois), larva. **H.** *Amauronematus* nr. *neglectus* (Kirby) larva. **I.** *A.* nr. *orbitalis* Marlatt larva. **J.** *A.* nr. *lineatus* (Harrington) larva.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LEAF SKELETONIZERS (Figure 97)

Distribution, Hosts, and Importance

Two taxonomic groups of insects commonly cause damage to hardwoods by skeletonizing the leaves. The pear sawfly, ***Caliroa cerasi*** (Linnaeus), has a worldwide distribution and attacks mountain-ash, hawthorn, and many other pomaceous species. It is primarily a pest of ornamental plantings. Another *Caliroa* species causes skeletonizing of bur oak leaves, particularly sucker growth. The birch skeletonizer, ***Bucculatrix canadensisella*** Chambers, is native to North America and has a transcontinental distribution. It is one of the most serious pests of birch, and periodic outbreaks are common. Its principal host in the prairie provinces is white birch.

Life Cycle and Appearance

Caliroa cerasi overwinters as larvae in small cocoons in the soil. It has one full generation per year plus a partial second generation. Pupation occurs in the spring. The small black sawfly adults (B) are about 5 mm long and emerge from mid-June until mid-July. The eggs are deposited on the lower surfaces of the leaves. The larvae hatch in about 2 weeks and move to the upper surfaces of the leaves to feed. They are shiny black and sluglike in appearance (A). Fully grown larvae are about 11 mm long and are a translucent yellowish green (C). They drop to the ground and spin tiny cocoons in the soil, where some pupate and emerge as adults. If the weather is suitable, this second generation may complete its development before the onset of cold weather. Another *Caliroa* species (possibly *C. obsoleta* (Norton)) probably has a similar development cycle, but little is known about its life history in the prairie provinces. The larvae are also sluglike and are usually covered with a slimy substance. They are whitish or yellowish green in color (D) and are about 13 mm long when fully grown.

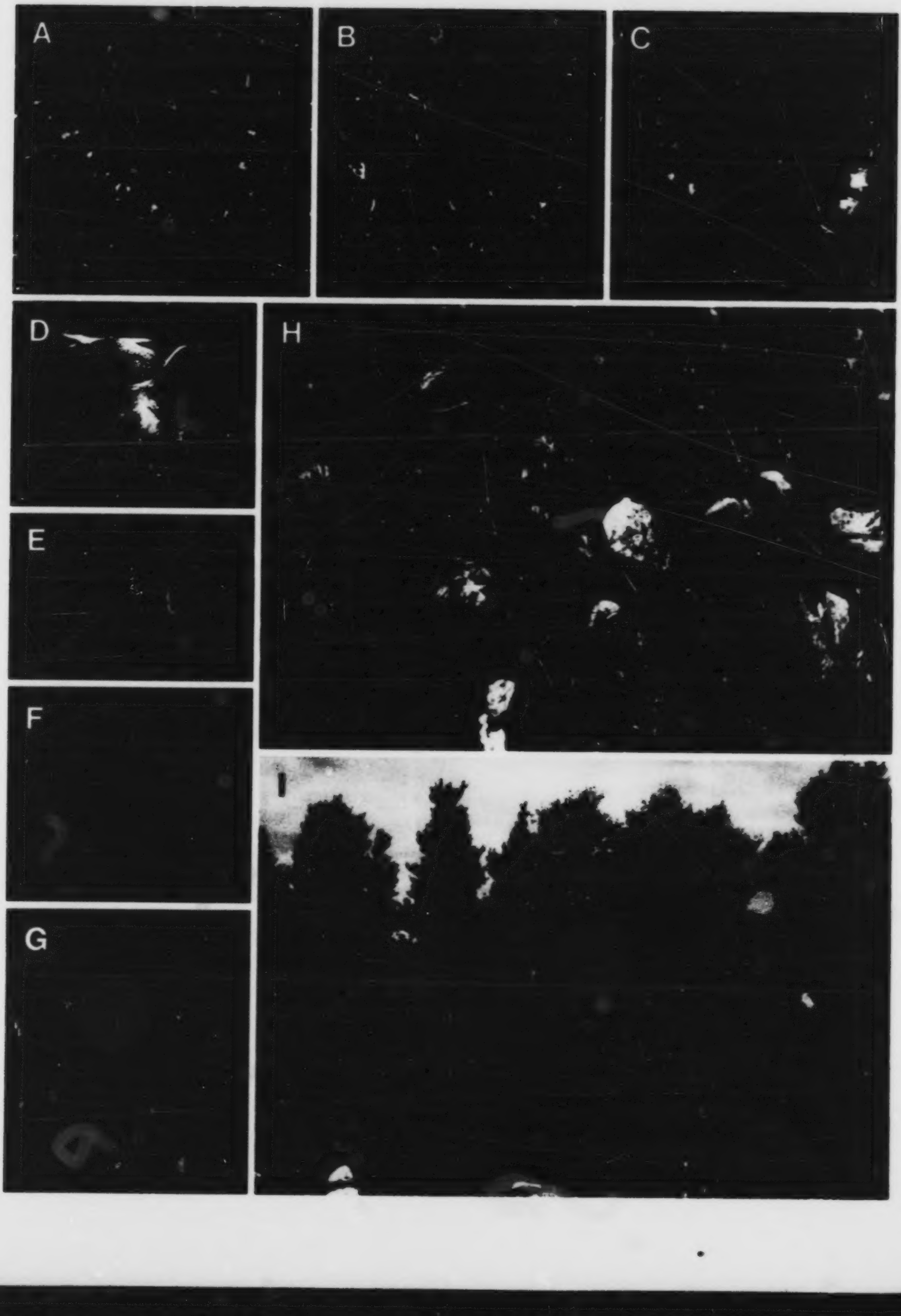
Bucculatrix canadensisella probably has one generation per year in the prairie provinces and overwinters as pupae in cocoons spun in the litter. The tiny moths, which have a wingspan of about 7 mm, are brown in color with transverse white bands on the front wings (E). The hind wings are gray and are fringed with hairs. Young larvae are white and legless and mine the leaf tissues. Older larvae are cylindrical and have functioning legs. They have brown heads and yellowish green bodies and measure about 6 mm long when fully grown (F). The older larvae feed on the parenchymatous tissue between the veins of the leaves. All larval instars, including the leaf-mining stages, spin white silken tents on the leaves in which they molt (G). When feeding is completed, the mature larvae spin ribbed cocoons (G), usually in the litter beneath the trees.

Damage

The feeding damage of both groups of leaf skeletonizers initially causes the damaged foliage to assume a bleached appearance. The leaves then turn a reddish brown (H), which often causes the leaves to drop prematurely. This usually has very little detrimental effect on the hosts, but their appearance becomes unsightly. Repeated severe attack by the birch skeletonizer may cause some loss of twigs in the upper crown and a slight reduction in annual radial increment but little permanent damage.

Bibliography: 60, 139, 297, 368, 476

Figure 97. Leaf skeletonizers. A. Group of pear sawfly, *Caliroa cerasi* (Linnaeus), larvae feeding on hawthorn. **B.** Adult *C. cerasi*. **C.** Mature *C. cerasi* larva. **D.** *Caliroa* sp. (possibly *C. obsoleta* (Norton)) larva on bur oak. **E.** Adult birch skeletonizer, *Bucculatrix canadensisella* Chambers. **F.** Late-instar *B. canadensisella* larvae. **G.** *B. canadensisella* molting tent (right) and cocoon (left). **H.** White birch stand damaged by *B. canadensisella*.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LEAF-MINING SAWFLIES ON BIRCH (Figure 98)

Distribution, Hosts, and Importance

Three species of small sawflies mine the leaves of native and introduced birches in the prairie provinces. The birch leafminer, ***Fenusa pusilla*** (Lepeletier), was accidentally introduced from Europe into North America in 1923. It was first noted in Quebec in 1929 and has since spread as far west as Alberta. The late birch leaf edgeminer, ***Heterarthrus nemoratus*** (Fallen), was also an accidental introduction from Europe. It was first reported from Pictou, Nova Scotia, in 1908 and has also spread as far west as Alberta. The ambermarked birch leafminer, ***Profenusa thomsoni*** (Konow), was first described in Europe and is now Holarctic in distribution. Severe infestations of all three species have persisted in the prairie provinces for a number of years. The insects are primarily pests of ornamental plantings.

Life Cycle and Appearance

Fenusa pusilla usually has two generations per year in the prairie provinces but may have a partial third generation if the frost-free period is long and the weather is unusually warm. The insect overwinters as a prepupal larva in a small cocoon beneath the trees. The adults emerge in late May. They are small black sawflies with yellowish brown legs and are 2.5–3.5 mm long. The females lay their eggs in slits cut in the upper surface of young leaves, usually towards the middle of the leaf. The larvae feed on the leaf tissue between the two epidermal layers. Several larvae may feed together within one mine (D). The larvae have four feeding instars and a fifth nonfeeding instar. Fully fed fourth-instar larvae have brown heads and creamy-white bodies and are 5.3–6.5 mm long (A). They have claws on the thoracic legs and can be recognized by the midventral black marks on the three thoracic segments and first abdominal segment. The second generation develops 45–50 days after the first. Oviposition is still concentrated on the young leaves, so that most mines are in the periphery of the crown.

Heterarthrus nemoratus has a single generation per year and overwinters as a prepupal larva in a silken hibernation cell within the mined leaf. The black and white parthenogenetic females emerge in late May or June and lay their eggs in slits cut into the edge of the leaves (E). The larvae have dark heads and creamy-white bodies and measure about 8 mm long when fully grown (B). They have no claws on the thoracic legs. There is a conspicuous dark ventral patch on the prothorax and a much smaller, dark midventral patch on each of the other two thoracic segments. This species can be recognized most easily, however, by the relatively clean-looking mines (G) and the presence of silken hibernation cells in the fallen leaves.

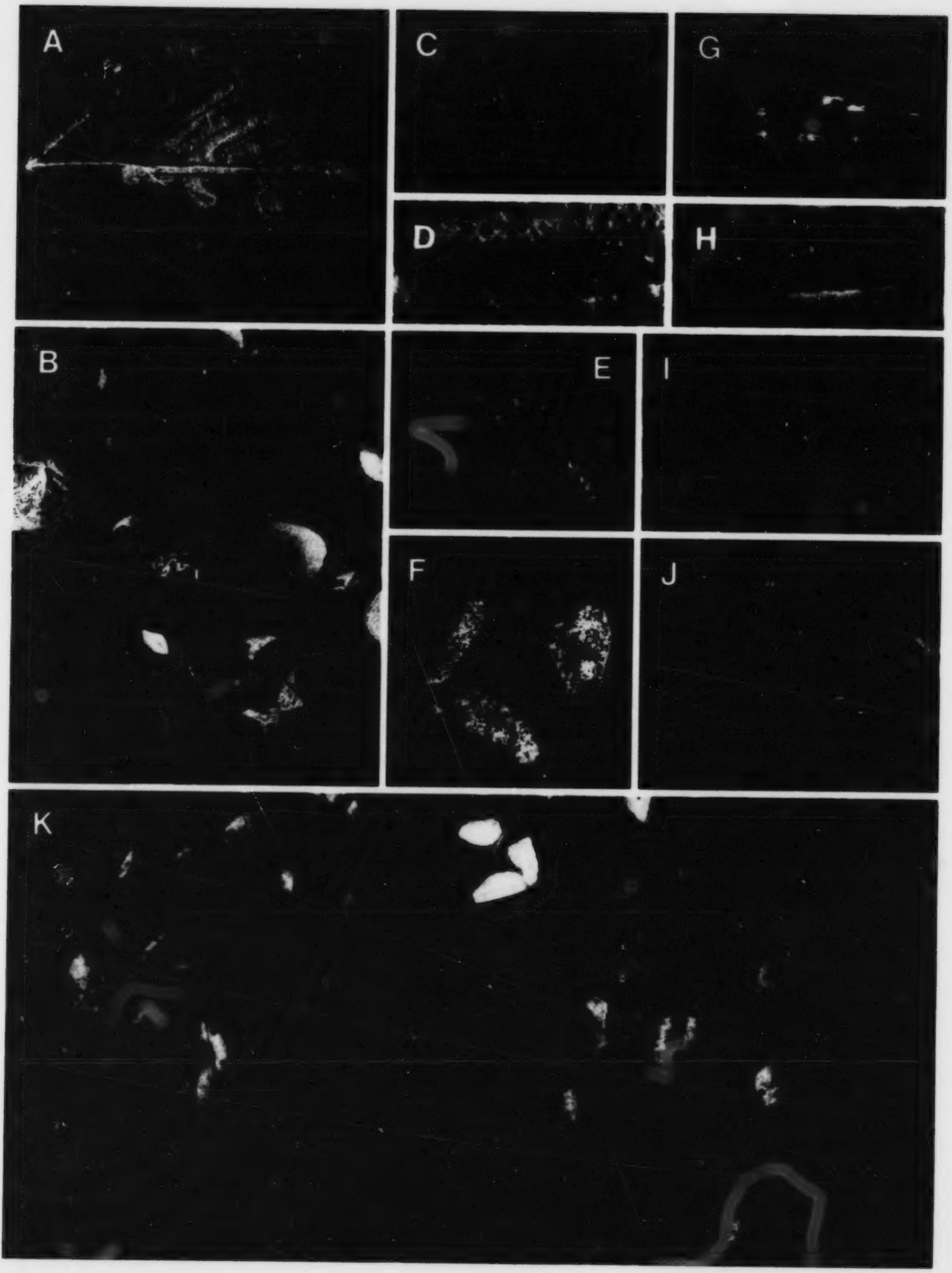
Profenusa thomsoni has one generation per year and overwinters as a prepupal larva in a tiny cocoon spun in the soil beneath the trees. The parthenogenetic females emerge in July. They are small black sawflies with white legs. Eggs are laid in slits along the veins in the basal and central area of the upper surface of the leaves (F). The larvae have five feeding instars and a sixth nonfeeding instar. They have light-colored heads and creamy-white bodies and are about 7 mm long when fully grown. There are no claws on the thoracic legs. There is a conspicuous midventral light-colored patch on the prothorax and a much smaller, dark midventral patch on each of the other two thoracic segments (C). Mines of several larvae usually coalesce and contain conspicuous frass (G).

Damage

The mining by the various birch leaf miners causes the leaves to dry out and turn brown (H). This does not seriously affect the health of the tree unless the mining is unusually severe, but the annual increment may be reduced slightly. The affected trees (I) become very unsightly, however, and birches are becoming unpopular as ornamentals in some areas because of this recurrent discoloration.

Bibliography: 98, 139, 146, 298, 332, 334, 364, 368, 476, 600

Figure 98. Leaf-mining sawflies on birch. **A.** Birch leafminer, *Fenusa pusilla* (Lepeletier), larva. **B.** Late birch leaf edgeminer, *Heterarthrus nemoratus* (Fallen), larva. **C.** Ambermarked birch leafminer, *Profenusa thomsoni* (Konow), larva. **D.** *F. pusilla* mine in white birch leaf. **E.** Edge of white birch leaf showing early mining by *H. nemoratus*. **F.** *P. thomsoni* egg punctures and early larval mining in a white birch leaf. **G.** *P. thomsoni* (upper left) and *H. nemoratus* (lower) mines in a white birch leaf. **H.** White birch leaves mined by *F. pusilla* and *P. thomsoni* larvae. **I.** White birch trees severely attacked by *P. thomsoni*.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POPLAR LEAF MINERS (Figure 99)

Distribution, Hosts, and Importance

The larvae of several small moths mine the leaves of poplar and willow. Three of the more common poplar infesting species in the prairie provinces will be discussed. Information on distribution is scanty because taxonomic relationships between the different species are not fully understood.

The aspen serpentine leafminer, ***Phyllocnistis populiella*** Chambers, forms serpentine mines in the upper and lower surfaces of trembling aspen leaves. Similar mines are sometimes found on other tree species, but these are probably caused by related but undescribed species. The larvae of two species of ***Phyllonorycter***, referred to in the literature as *P. salicifoliella* (Chambers) and *P. nipigon* (Freeman), form blotch mines on the underside of trembling aspen and balsam poplar leaves, respectively. The two species, for convenience, will be referred to here as ***P. nr. salicifoliella*** and ***P. nr. nipigon***. Although all three species occasionally become locally abundant, none are of economic importance.

Life Cycle and Appearance

Phyllocnistis populiella has one generation per year and overwinters in the adult stage. The tiny, mainly whitish moths have a wingspan of about 5 mm and emerge from hibernation more or less coincident with the flushing of trembling aspen foliage. They feed on nectar produced by glands near the base of some of the young trembling aspen leaves. Eggs are laid on both the upper and lower surfaces of the leaves, although the majority are on the upper surface. The young larva enters the leaf by chewing its way through the bottom of the egg. The larvae have four instars. The first three instars have sickle-shaped mandibles and consume only the epidermal cells, without breaking the cuticle. The larvae meander back and forth in the leaf, leaving a streak of frass (A, B). They are 3–6 mm long when fully grown. Fourth-instar larvae have no functioning mouth parts. They spin silken cells within the mines, in which pupation occurs. Adults emerge in late July or early August. They are active for several weeks before they disappear, presumably to hibernate in the duff.

Phyllonorycter* nr. *salicifoliella has one generation per year and overwinters in the adult stage. The small brown and white moths (C) have a wingspan of 8–9 mm and emerge from hibernation when the leaves on trembling aspen are expanding. Eggs are laid on the underside of the leaves, usually near the edge. The larvae bore through the bottom of the egg and through the epidermis to feed on the spongy parenchyma cells. There are five larval instars. The first three are creamy colored and flattened and can feed only in a single plane. The mines are circular at first but assume an oblong shape by the end of the third instar (F). The fourth- and fifth-instar larvae are circular in cross section and gradually consume the parenchyma tissue below them without otherwise enlarging the mine. The fourth-instar larva spins a heavy layer of silk on the inside of the epidermis. The silk contracts as it dries, creating a bulge typical of blotch miners. Mature larvae are about 6 mm long, and the gonads show through the integument, causing the last four abdominal segments to become orange-yellow in color (E). They spin a silken cell within the mine, and the pupae (D) develop soon afterwards. Adults emerge during late August and are active for a short period before hibernating. The location of the hibernation sites is unknown, although it has been speculated to be under the bark scales of coniferous trees.

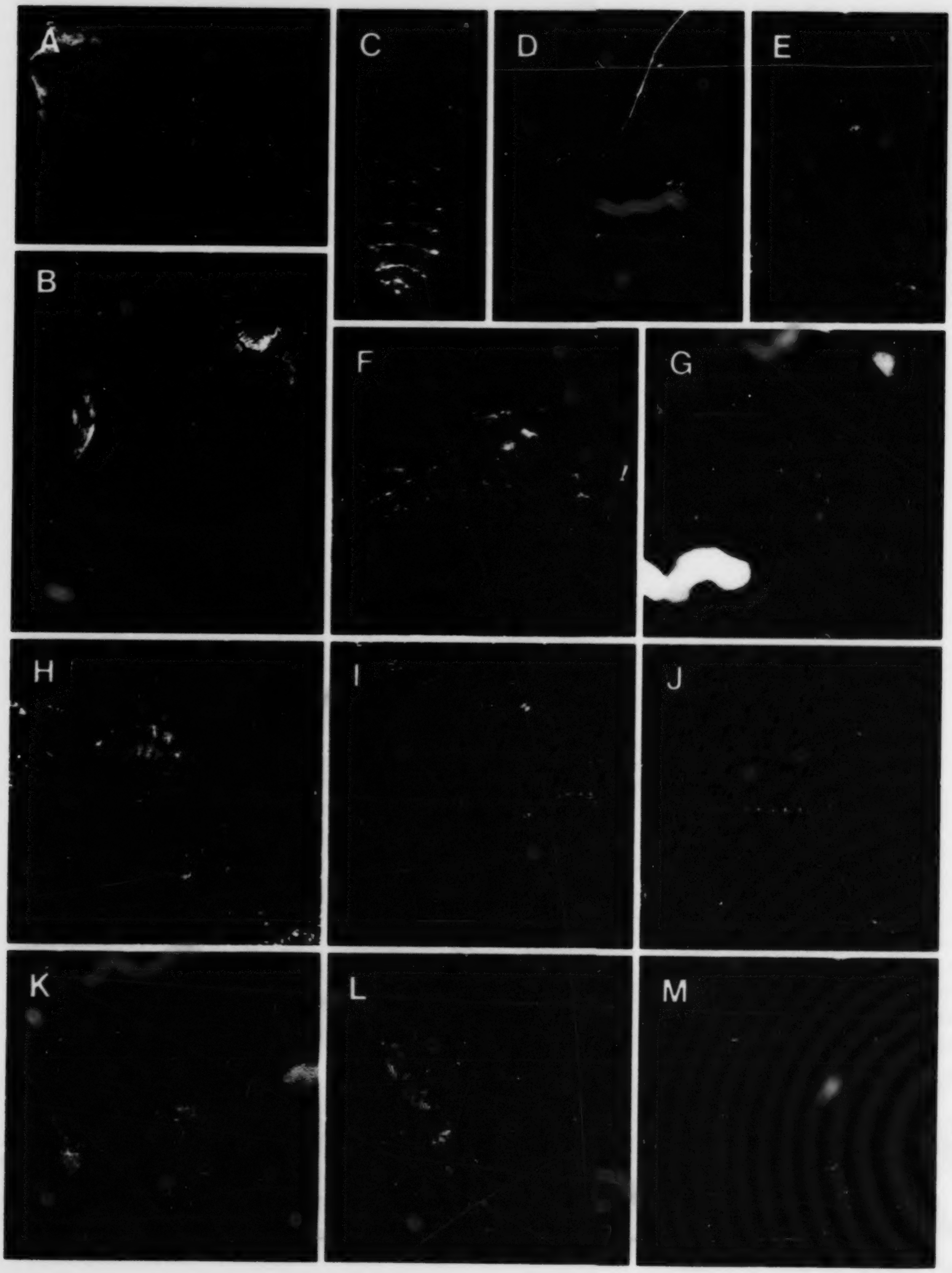
Little is known about the life cycle of ***Phyllonorycter*** nr. ***nipigon***, although it is probably very similar to that of *P.* nr. *salicifoliella*. The adults (G) and pupae (H) are both darker in color but are otherwise very similar to *P.* nr. *salicifoliella*, as are the larvae (I) and mines (J). The black marks on the abdomens of the larvae are very prominent in late instars. Adults emerged in late August from field-collected pupae, so there is probably one generation per year.

Damage

The above three species of leaf miners have little adverse effect on the host trees. The mining of the leaf tissue (K) causes the leaves to dry out and turn brown, however, and may lead to premature leaf drop, especially during severe infestations. This may be undesirable in a parkland setting.

Bibliography: 59, 95, 107, 108, 197, 363, 476, 599

Figure 99. Poplar leaf miners. A. The aspen serpentine leafminer, *Phyllocnistis populiella* Chambers, in a trembling aspen leaf. **B.** Trembling aspen leaves mined by *P. populiella*. **C.** Adult *Phyllonorycter* nr. *salicifoliella* (Chambers). **D.** *P.* nr. *salicifoliella* pupa. **E.** *P.* nr. *salicifoliella* larva. **F.** Group of *P.* nr. *salicifoliella* mines in a trembling aspen leaf. **G.** Adult *P.* nr. *nipigon* (Freeman). **H.** *P.* nr. *nipigon* pupa. **I.** *P.* nr. *nipigon* larva. **J.** Balsam poplar leaf mined by *P.* nr. *nipigon*. **K.** Trembling aspen leaves mined by *P.* nr. *salicifoliella*.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MISCELLANEOUS LEAF MINERS (Figure 100)

Distribution, Hosts, and Importance

Messa leucostoma (Rohwer) attacks a variety of poplars, particularly in southern Saskatchewan. The cottonwood leafmining beetle, ***Zeugophora scutellaris*** Suffrian, and ***Z. abnormis*** LeConte are sometimes locally abundant on cottonwoods or hybrid poplars and balsam poplar, respectively. The lilac leafminer, ***Gracillaria syringella*** (Fabricius), is a European species that is now common on lilac in the southern half of Alberta. The European alder leafminer, ***Fenusa dohrnii*** (Tischbein) is another introduced insect that is now widely distributed on alder in Canada. The solitary oak leafminer, ***Cameraria hamadryadella*** (Clemens), and ***C. macrocarpae*** Freeman both attack bur oak in Manitoba. None of the above species are of economic importance.

Life Cycle and Appearance

Messa leucostoma probably has one generation per year in the prairie provinces and overwinters as prepupae in the soil. Adults emerge in late May or early June. They are small yellowish brown sawflies about 4 mm long. Females mate and deposit eggs in slits cut near the margins of the expanding leaves. The larvae eat the parenchymous tissue of the leaf (A). They are creamy-white with brown heads and thoracic plates and reach a length of 7–9 mm when fully grown. There are five feeding instars and a sixth nonfeeding instar. The larvae drop to the ground in early July and form earthen cells in which they overwinter.

Zeugophora scutellaris and ***Z. abnormis*** have similar life cycles. Both species have one generation annually and overwinter as mature larvae in earthen cells. The small beetles, about 4 mm long, emerge in mid-June and feed on the underside of the leaves. *Zeugophora scutellaris* have yellow thoraxes and black elytra, and *Z. abnormis* are all black. The females mate and start laying eggs in late June. The flat, yellow, legless larvae (C) feed on the pallisade cells and reach a length of 5–8 mm when fully grown in late August. The spongy parenchyma cells under the mines turn black and can be seen through the upper epidermis (D, E). *Zeugophora scutellaris* larvae can usually be separated from those of *Z. abnormis* by the presence of transverse black bars on the dorsal and ventral areas of most abdominal segments.

Gracillaria syringella has two generations per year in the prairie provinces and overwinters as pupae in small cocoons in the soil. The moths emerge in late May or early June. They have variegated yellowish white, gray, gold, and brown front wings, with a span of 11–12 mm. Eggs are laid in rows adjacent to a vein on the underside of the leaves. There are five larval instars. Larvae in the first three instars mine the leaves, and those in the last two instars roll them. The larvae (F) are legless and when mature are cylindrical, creamy-white, and 4.5–8.0 mm long. First-generation larvae drop to the ground in early July. Second-generation adults emerge in late July or early August, and larval development in this generation is completed by mid-September.

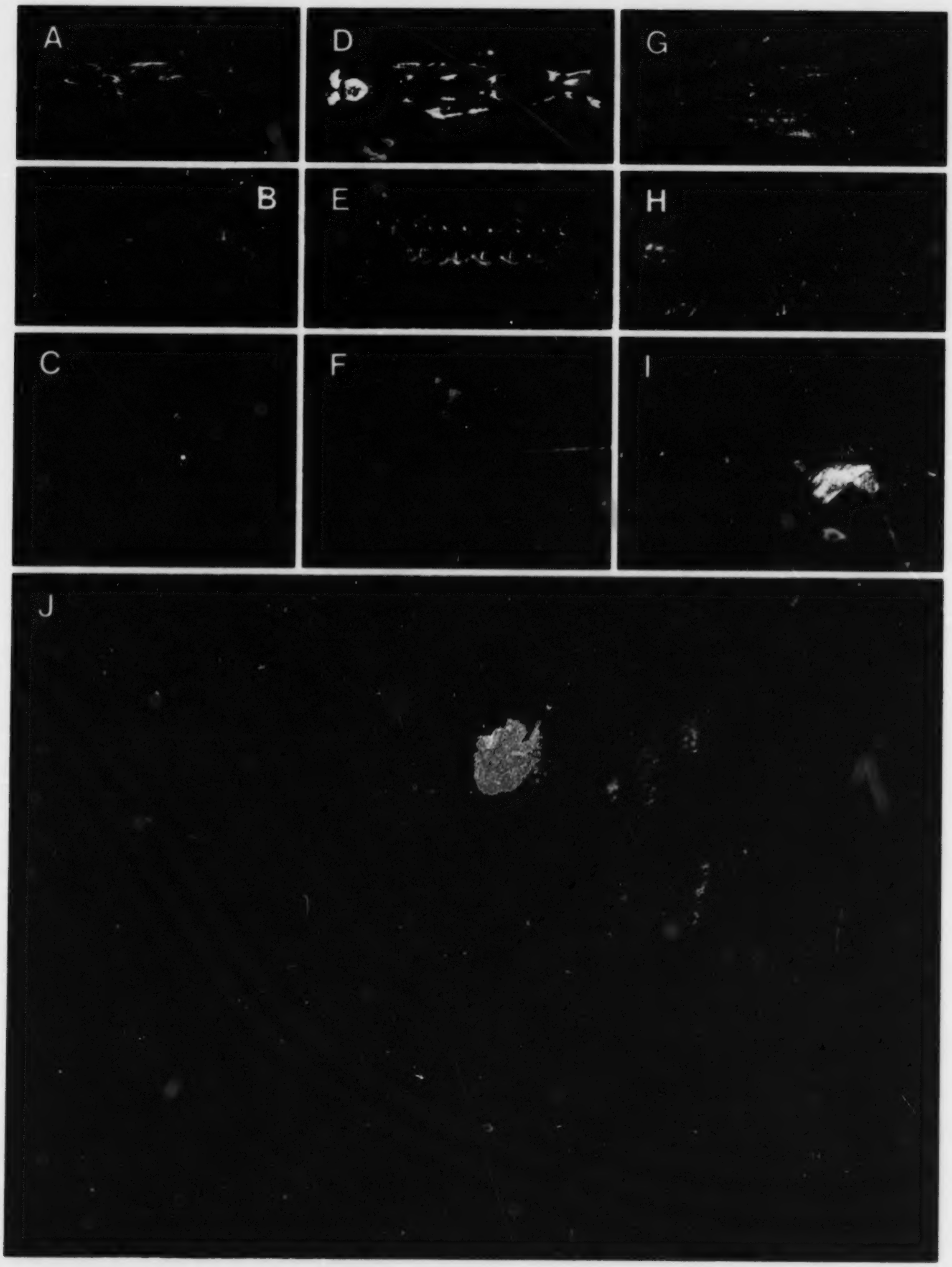
The life cycle of ***F. dohrnii*** in the prairie provinces is probably similar to that of *F. pusilla* (Fig. 98). The larvae are creamy-white grubs with brown heads and well-developed thoracic legs (H). Mines are formed on the upper leaf surface (K). ***Cameraria macrocarpae*** has one generation per year in Manitoba and overwinters as sixth-instar larvae within the mines. Seventh-instar larvae spin pupal cells within the mines between mid-May and mid-July, and the adults emerge about 3 weeks later. They are small moths with yellowish brown front wings traversed by three V-shaped white bands. They have a wingspan of about 8 mm. Eggs are laid in clusters on the upper leaf surfaces, and the larvae feed gregariously on the pallisade cells of the leaves. They have five feeding and two nonfeeding instars. The creamy-white larvae in the mining stage are flattened and legless and have brown, wedge-shaped heads (I); those in the spinning, nonfeeding stage are more cylindrical. The epidermis over the mines usually becomes brownish and hardened, especially in the older portions of the mines (L). ***Cameraria hamadryadella*** probably has two generations annually in Manitoba, and the insect overwinters as sixth- or seventh-instar larvae within the mines. Adults emerge in late spring and lay individual eggs on the upper leaf surfaces. The yellowish brown, flattened larvae are solitary feeders (J). The epidermis over the mined areas has a papery appearance (M).

Damage

The larval feeding damage by this group of insects has little adverse affect on the health of the trees. The mined leaves (B, D, E, G, K, L, M) are unsightly, however, and this may spoil the appearance of ornamental plantings.

Bibliography: 139, 196, 224, 264, 424, 476, 502, 557, 561, 573, 587, 603, 653

Figure 100. Miscellaneous leaf miners. A. *Messa leucostoma* (Rohwer) larva in mine on balsam poplar leaf. **B.** Two *M. leucostoma* mines on balsam poplar leaf. **C.** Mature cottonwood leafmining beetle, *Zeugophora scutellaris* Suffrian, larva. **D.** *Z. scutellaris* mines on eastern cottonwood leaf. **E.** *Z. abnormis* LeConte mine on balsam poplar leaf. **F.** Mature lilac leafminer, *Gracillaria syringella* (Fabricius), larva. **G.** *G. syringella* mine on lilac leaf. **H.** European alder leafminer, *Fenusa dohrnii* (Tischbein), larva. **I.** *Cameraria macrocarpae* Freeman larvae. **J.** Solitary oak leafminer, *Cameraria hamadryadella* (Clemens), larva. **K.** *F. dohrnii* mines on speckled alder leaf. **L.** *C. macrocarpae* mines on bur oak leaf. **M.** *C. hamadryadella* mine on bur oak leaf.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LEPIDOPTEROUS LEAF MINERS AND CASEBEARERS ON HARDWOODS
(Figure 101)

Distribution, Hosts, and Importance

Two little-known lepidopterous leaf miners have occasionally been locally abundant in recent years. ***Lyonetia*** nr. ***prunifoliella*** Hübner was found on white birch in Yoho National Park, and the willow leafminer, ***Micrurapteryx salicifoliella*** (Chambers), was widespread on willow in north-central Saskatchewan.

Several species of ***Coleophora***, called casebearers, occur on hardwoods in this region. An unidentified species, possibly the cigar casebearer, *C. serratella* (Linnaeus), attacks white birch in southeastern Manitoba and is shown as an example of this genus.

None of these insects are of economic importance.

Life Cycle and Appearance

The life cycles of these insects are not fully understood, and taxonomic studies are required to determine the identity of the above species. All are believed to have one generation per year in the prairie provinces. ***Lyonetia* nr. *prunifoliella*** overwinters in silken cocoons that are usually spun on the foliage but may be almost anywhere when population levels are high. The tiny grayish moths (A) emerge in late spring and have a wingspan of about 8 mm. They have a tuft of hair on the head, long slender antennae, and slender wings with fringes of long hairs on the hind edges. The front wings are gray with brown bars, and the hind wings are gray. The larvae (B) have greenish brown heads and pale green bodies and reach a length of about 7 mm when mature. Young larvae excavate narrow, serpentine mines that abruptly change to blotch mines (C) when the larvae grow older. Pupation occurs in July or August.

Micrurapteryx salicifoliella adults (D) have a wingspan of about 8 mm and emerge in mid-August. They resemble those of *L.* nr. *prunifoliella*, but the background color is whitish, and the markings are black. The adults probably overwinter, but this has not been confirmed. The larvae (E) feed in blotch mines (F) during the summer. The larvae have brown heads and whitish bodies and reach a length of about 7 mm when mature.

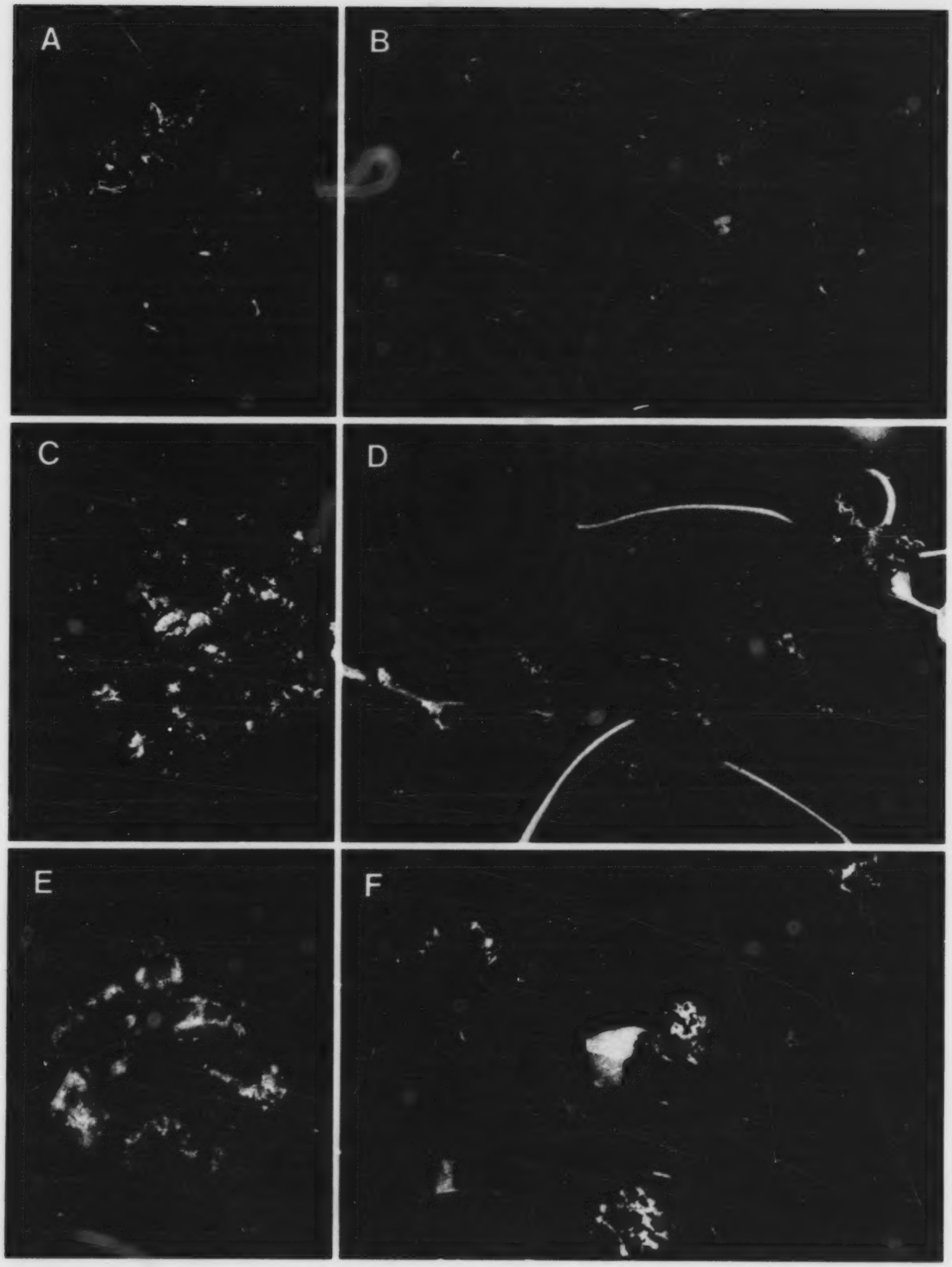
Coleophora* poss. *serratella overwinters as young larvae in cases attached to the bark. The larvae resume feeding in the spring and carry a cigar-shaped case (H) with them, anchoring it to the leaf surface with silk when feeding. They usually mine the leaf (I) by reaching as far as possible into the leaf without completely abandoning the case, but larvae have been observed feeding completely within the mines. Feeding is completed in June, and the adults emerge in July or early August. The tiny moths (G) have a wingspan of about 8 mm. They have slender, light brown wings, with fringes of long hairs on the hind edge of each wing. Eggs are laid on the foliage, and the young larvae mine the leaves briefly before constructing the overwintering cases.

Damage

Severe infestations by any of these insects causes browning of the foliage (J). This damage renders the affected trees unsightly but causes little permanent injury.

Bibliography: 94, 139, 476

Figure 101. Lepidopterous leaf miners and casebearers on hardwoods. A. Adult *Lyonetia* nr. *prunifoliella* Hübner collected from white birch. **B.** *L.* nr. *prunifoliella* larva. **C.** *L.* nr. *prunifoliella* mines in white birch leaf. **D.** Adult willow leafminer, *Micrurapteryx salicifoliella* (Chambers). **E.** *M. salicifoliella* larva. **F.** *M. salicifoliella* mines. **G.** Adult *Coleophora* sp. (possibly the cigar casebearer, *C. serratella* (Linnaeus)) collected from white birch. **H.** *Coleophora* sp. larva in case. **I.** Birch leaf mined by *Coleophora* sp. larva. **J.** White birch trees damaged by *L.* nr. *prunifoliella*.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LEAF AND BUD GALLS ON POPLAR (Figure 102)

Distribution, Hosts, and Importance

Some mites and aphids stimulate their hosts' tissues to form galls that bear little resemblance to the original leaf or bud. Three of these types of galls are commonly found on various poplars in the prairie provinces. ***Aceria* nr. *dispar*** (Nalepa) is a minute mite that causes damage on trembling aspen. This damage ranges from leaf rolling to complete distortion of the terminal leaf clusters, depending upon the amount of development of the host leaf tissue at the time of attack. Severe infestations sometimes occur on aspen regeneration.

The poplar budgall mite, ***Aceria parapopuli*** Keifer, causes galls to form by bud proliferation. It is particularly abundant on plantings of northwest poplar and other poplar hybrids in the southern parts of the prairie provinces. Other poplar species are attacked, but the infestations are usually scattered and of little importance. The poplar vagabond aphid, ***Mordwilkoja vagabunda*** (Walsh), produces conspicuous galls on the terminals of a number of poplar species. It has occasionally been locally abundant on trembling aspen and balsam poplar in Manitoba and Saskatchewan but is of little economic importance.

Life Cycle and Appearance

The life cycles of eriophyid mites, the group to which the genus *Aceria* belongs, range from the simple form, involving only one type of reproducing female, to the complex, where there are two or more types of females. Little is known about the life cycle of ***A.* nr. *dispar*** (A). ***Aceria parapopuli*** probably has a simple life cycle involving eggs, nymphs, and adults. All stages apparently overwinter in the galls. Activity begins early in the spring, when the adults mate and start to reproduce. The cigar-shaped female mites are about 0.2 mm long when fully grown, have two pairs of legs, and range from greenish white to a dark reddish orange in color. The nymphs resemble the adults but are smaller. The life cycle is completed in 10-21 days. There may be as many as eight generations annually in the prairie provinces. Mites disperse from existing galls when the buds are expanding. Some crawl over the twig and bud surfaces and may establish feeding sites on buds or expanding leaves, stimulating them to form galls. Others are carried to new hosts on air currents. The galls are fleshy when first formed (C), but soon become hard and corklike. Most galls contain mites for 1-4 years, but others may be occupied for 10-15 years.

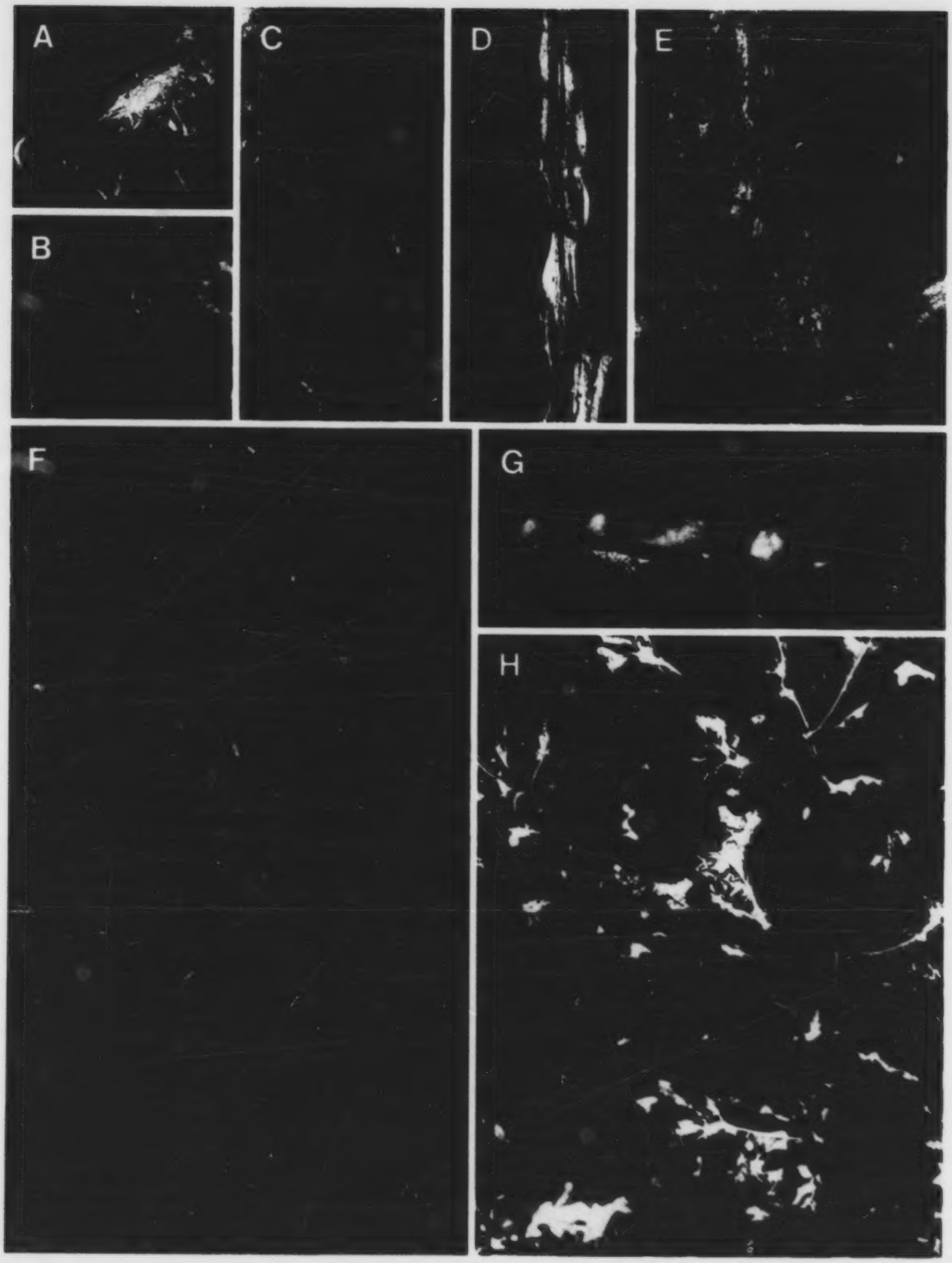
Mordwilkoja vagabunda has a complex life cycle involving sexual and asexual reproduction, winged and wingless forms, and alternation between primary and secondary hosts. The insect overwinters in the egg stage, usually in or near galls formed the previous summer. The young aphids start feeding in groups on the developing shoots early in the spring, and this stimulates the gall formation by causing the leaves to curl downwards to enclose the aphids (E). The young nymphs are greenish but become creamy colored as they grow older. After reaching maturity, when they measure 4-5 mm in length, the females start producing numerous living young. These develop into winged females that leave the galls in July and early August. They migrate to loosestrife, the secondary host, where they deposit nymphs. Initially the nymphs feed on the leaves and upper stem but ultimately migrate to the underground stem and roots. The aphids can apparently reproduce on loosestrife indefinitely. Winged sexual forms are usually produced in the fall, and the mated females migrate to poplar to lay their eggs.

Damage

None of these gall formers cause any serious damage, although the galls are unsightly (B, D, F,). Those of ***A. parapopuli*** persist for many years, and some lower branches may be literally covered with them. Some branch mortality may occur, but this is probably due to natural pruning rather than to the presence of the galls.

Bibliography: 139, 289, 297, 304, 306, 476, 523, 627

Figure 102. Leaf and bud galls on poplar. A. Close-up of galls on trembling aspen caused by the mite, *Aceria* nr. *dispar* (Nalepa). **B.** Young aspen heavily infested with *A.* nr. *dispar*. **C.** Close-up of gall caused by the poplar budgall mite, *A. parapopuli* Keifer. **D.** Twig heavily infested with *A. parapopuli*. **E.** Close-up of gall on balsam poplar caused by the poplar vagabond aphid, *Mordwilkoja vagabunda* (Walsh). **F.** Balsam poplar heavily infested with *M. vagabunda*.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GALL WASPS ON BUR OAK (Figure 103)

Distribution, Hosts, and Importance

A large number of minute wasps cause various types of leaf and twig galls on bur oak in the prairie provinces (Figs. 75, 104). Many of these insects have complicated life cycles involving alternating generations and sexual and parthenogenetic reproduction. The appearance of the same species of insect and the galls that they cause in alternating generations are often very dissimilar, creating taxonomic confusion that masks the relationship between the two generations. ***Callirhytis* nr. *flavipes*** (Gillette), which alternately produces twig and leaf galls on bur oak, is very common in Edmonton and will be used as an example. It is currently of no economic importance but is a potentially serious pest of bur oak in ornamental plantings.

Life Cycle and Appearance

The life cycle of ***C.* nr. *flavipes*** is not fully understood because the relationship between the alternating generations has only recently been established, but it is believed to be as follows. There are two generations per year, an asexual overwintering generation and a sexual summer generation. Adults of the overwintering generation (A) emerge in late April or early May. All of the adults are females that reproduce parthenogenetically. They are minute dark brown or black wasps, about 2.5 mm long, with pale legs and antennae. They are believed to enter the tightly packed buds and to lay their eggs on the midveins of the rudimentary leaves. This stimulates the ultimate formation of single-celled or multicelled galls on the affected leaves by early summer (G, H).

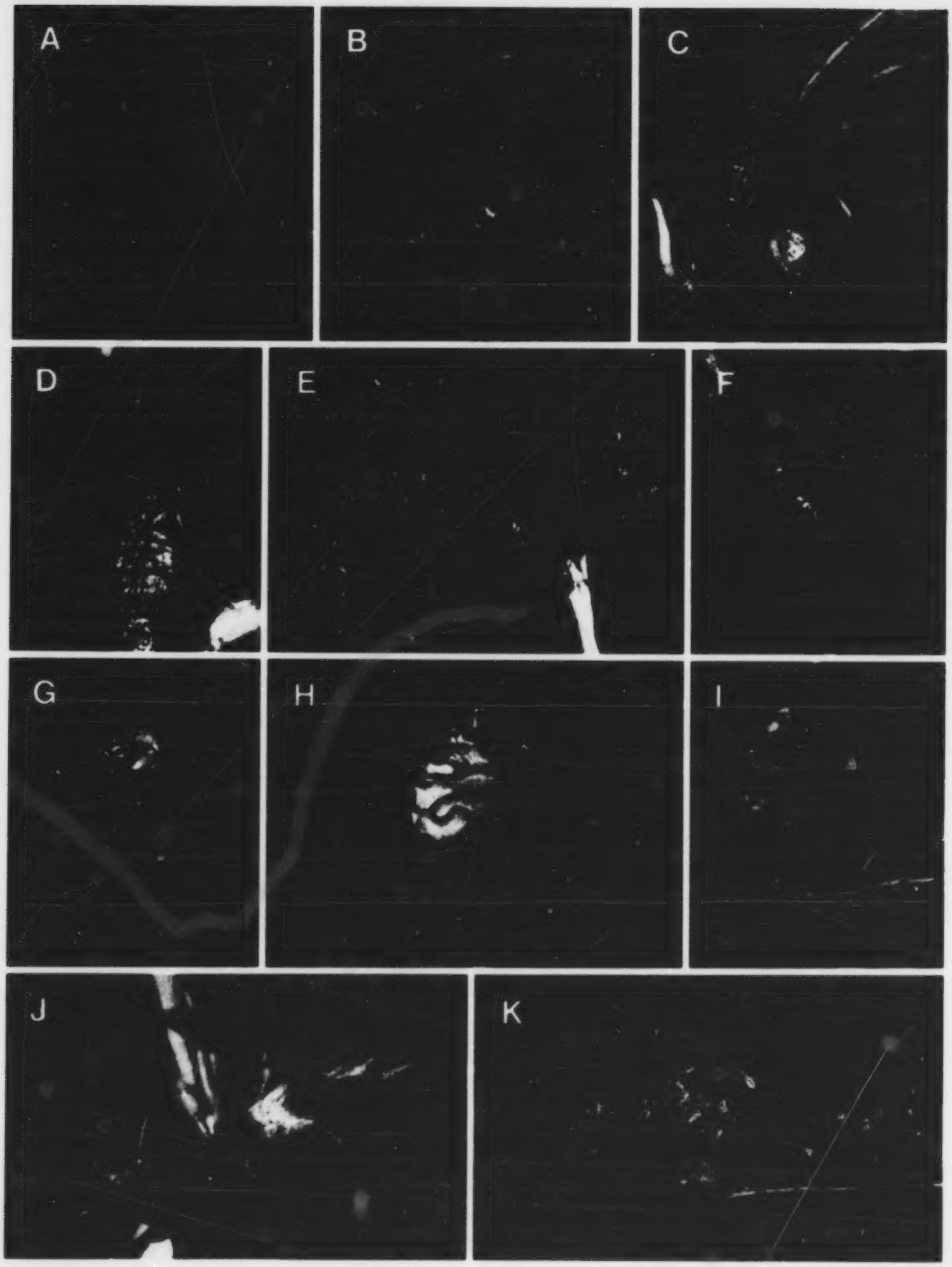
The sexual generation adults (not shown) emerge from these galls in mid-July. They mate, and the females lay their eggs in the bark. Most oviposition occurs on the current season's growth when population levels are low but may occur on larger twigs and branches when population levels are high. This stimulates the formation of single-celled galls (C–F), each containing a small, yellowish, legless larva (B). The galls are inconspicuous and resemble the normal corky ridges that occur on bur oak twigs. Pupation occurs in early spring, and the adults emerge a few days later.

Damage

Severe infestations of the summer generation of *C.* nr. *flavipes* make the leaves of bur oak unsightly (H), and this is undesirable in ornamental plantings. The overwintering generation causes the greatest amount of damage, however, and is directly responsible for killing young twigs. This produces an undesirable bushy growth that detracts from the tree's appearance. The greatest amount of damage is caused by downy woodpeckers searching for the larvae (F). They sometimes remove most of the outer bark from the branches and upper trunk of young trees.

Bibliography: 81, 123, 135, 170, 284, 310, 342, 343, 344, 479, 480, 604, 605, 606, 607, 608

Figure 103. Gall wasps on bur oak. **A.** Adult female *Callirhytis* nr. *flavipes* (Gillette) from asexual overwintering generation. **B.** Larva of overwintering generation. **C.** Bur oak twig with part of bark removed to show cells that contained overwintering larvae. **D.** Bur oak twig infested with overwintering generation of C. nr. *flavipes*. **E.** Bur oak twig showing emergence holes of overwintering generation of C. nr. *flavipes*. **F.** Downy woodpecker damage to bur oak branch infested with overwintering generation of C. nr. *flavipes*. **G.** Close-up of bur oak leaf infested with the sexual summer generation of C. nr. *flavipes*. **H.** Bur oak leaves infested with the summer generation of C. nr. *flavipes*.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PERSISTENT GALLS (Figure 104)

Distribution, Hosts, and Importance

A number of insects and mites cause the formation of galls that often persist on the host long after the organism responsible has completed its development. Most of these galls are on bur oak, willow, or poplar.

Andricus quercuspetiolicola (Bassett), ***Disholcaspis spongiosa*** (Karsch), and ***D. quercusmamma*** (Walsh) are examples of insect-caused galls that persist on bur oak in Manitoba. The willow beakedgall midge, ***Mayetiola rigidae*** (Osten Sacken); ***Oligotrophus salicifolius*** Felt; the willow potatogall midge, ***Rhabdophaga salicisbatatas*** (Osten Sacken); the willow cabbagegall midge, ***R. salicisbrassicoides*** (Packard); and the willow pinecone gall midge, ***R. strobiloides*** (Osten Sacken), are examples of insects causing galls on willow throughout the prairie provinces. Other galls commonly found throughout the region include the flower gall on ash caused by the ash flower gall mite, ***Aceria fraxiniflora*** (Felt), and a stem gall on trembling aspen caused by a midge, ***Melanagromyza*** sp. None of these gall-forming organisms are of economic importance, although some occasionally become very abundant in localized areas.

Life Cycle and Appearance

Very little is known about the life cycles of the tiny cynipid wasps that cause the persistent galls on bur oak. Male and female wasps of ***Andricus quercuspetiolicola*** emerge from the galls (A) in midsummer, and the females lay their eggs in the terminal buds. All of the ***Disholcaspis*** species are known only as parthenogenetic females that emerge from the galls (B, C, F) in late fall and lay eggs between the bud scales. Accumulating evidence suggests that an alternating asexual generation of *A. quercuspetiolicola* and an alternating sexual generation for each of the *Disholcaspis* species will ultimately be recognized.

Aceria fraxiniflora overwinter as fertilized females beneath the bud scales or in bark crevices on their host. They are wormlike mites, have two pairs of legs, and are about 0.2 mm long when mature. The females move onto the developing male flowers in the spring, and their feeding stimulates gall formation (E). Eggs are laid in the developing galls. After passing through two instars, the nymphs develop into the first summer generation of male and female mites that are identical to each other except for the genital organs. The females in this and subsequent generations become fertilized by picking up packets of sperm deposited by the males. A generation of overwintering females is produced in the fall. These become fertilized and then move to the overwintering sites.

All of the remaining galls (D, G–K) are caused by midges that are believed to have similar life cycles. Two species will be used as examples. ***Mayetiola rigidae*** has one generation per year and overwinters as third-instar larvae within the galls (D). The adult midges emerge in early spring. After mating, the females lay eggs singly on or near the developing buds. The young reddish larvae bore through the bud until they reach the small cavity in the center of the developing leaves, where their feeding stimulates gall formation. The larvae reach maturity in September. They are orange and have large, white fat bodies. Most of the leaves fall off the galls as they mature.

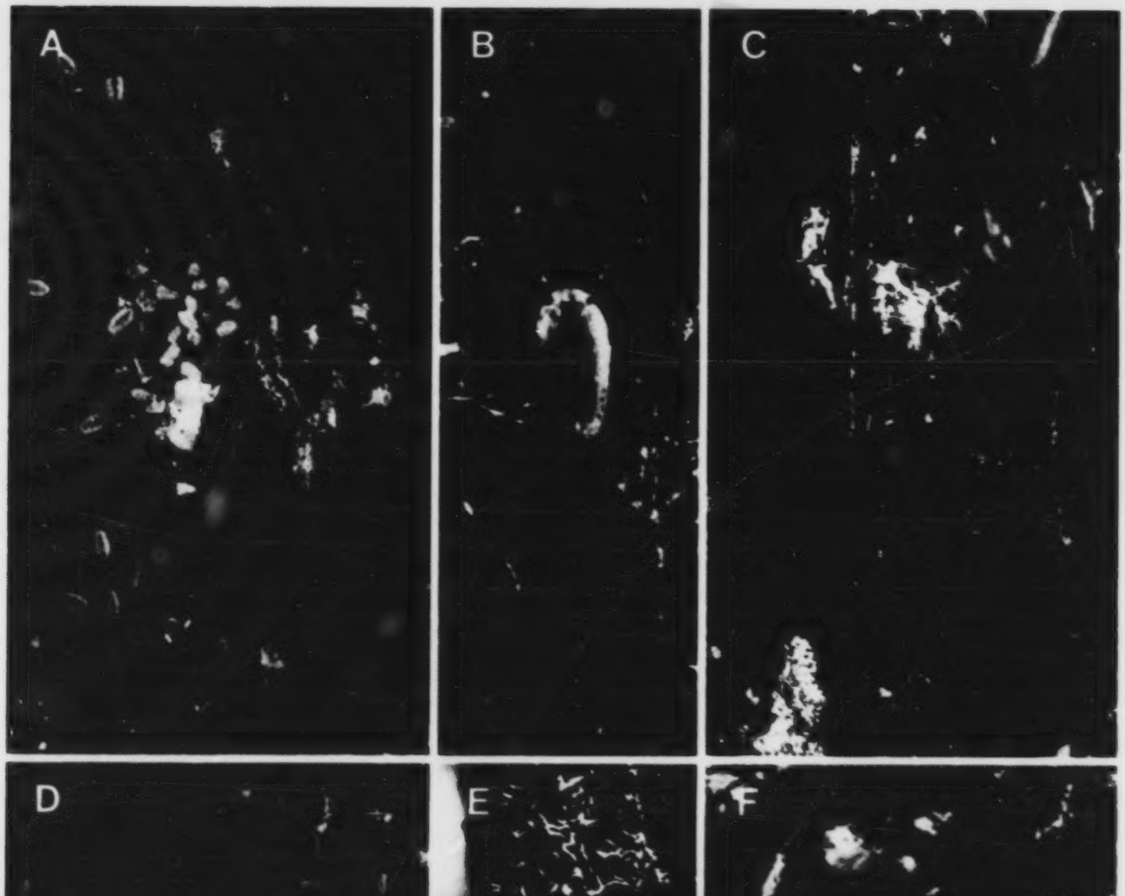
Rhabdophaga strobiloides has one generation per year and overwinters as third-instar larvae within the galls (H). The adult midges emerge in the spring just prior to the flushing of the willow leaves. After mating, the females lay eggs singly on the young leaves. The young light-orange larvae crawl to the developing tip and bore through the base of the leaves until they reach the central cavity. Their feeding stimulates the formation of a conelike gall (H). The larvae are tan or orange in color when they reach maturity in late September.

Damage

None of these gall-forming insects cause serious damage to their hosts, but heavy infestations create an unsightly appearance. This is particularly true of ash trees used as ornamentals. Male trees are often used in such plantings because of the heavy seed production on female trees. Heavy infestations of ***Aceria fraxiniflora*** sometimes make the male trees unattractive, however, as the galls often persist long after the mites have completed feeding.

Bibliography: 81, 123, 135, 170, 179, 230, 231, 295, 342, 360, 476, 479, 533, 552, 604, 606, 607, 620, 621, 651

Figure 104. Persistent galls. A. Gall on bur oak petiole caused by *Andricus quercuspetiolicola* (Bassett). **B.** Galls on bur oak twig caused by *Disholcaspis spongiosa* (Karsch). **C.** Fresh galls on bur oak twig caused by *D. quercusmamma* (Walsh). **D.** A gall on willow caused by the willow beakedgall midge, *Mayetiola rigidae* (Osten Sacken). **E.** Galls on ash caused by the ash flower gall mite, *Aceria fraxiniflora* (Felt). **F.** Dried *D. quercusmamma* galls. **G.** Galls on willow caused by the willow potatogall midge, *Rhabdophaga salicisbatatas* (Osten Sacken). **H.** Gall on willow caused by the willow pinecone gall midge, *R. strobiloides* (Osten Sacken). **I.** Galls on willow caused by *Oligotrophus salicifolius* Felt. **J.** Galls on willow caused by the willow cabbagegall midge, *R. salicisbrassicoides* (Packard). **K.** Gall on trembling aspen caused by a midge, *Melanagromyza* sp.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SCALE INSECTS ON HARDWOODS (Figure 105)

Distribution, Hosts, and Importance

Four of the more common species of scale insects that occur on hardwoods in the prairie provinces will be discussed. None are of major economic importance. The European fruit lecanium, ***Parthenolecanium corni*** (Bouché), feeds on white elm and a wide variety of other trees and shrubs. Identification of this and other species of *Parthenolecanium* is difficult because of the wide range in size and color of the insects on various hosts. Localized populations can build up to very high levels. The scurfy scale, ***Chionaspis furfura*** (Fitch), is found on white elm, ash, aspen, and other hardwoods. It also becomes very abundant in localized areas. The oystershell scale, ***Lepidosaphes ulmi*** (Linnaeus), is believed to have originated in Europe and is a pest on a wide variety of broad-leaved trees and shrubs. Severe attacks occasionally occur, primarily on ornamental trees and shrubs. The San José scale, ***Quadraspidiotus perniciosus*** (Comstock), may have originally been introduced from China. It also feeds on a wide variety of hosts, and severe infestations sometimes develop on ornamentals.

Life Cycle and Appearance

Parthenolecanium corni has one generation per year in the prairie provinces and overwinters as nymphs in bark crevices or under scales from the previous season. The nymphs emerge from hibernation from late March to early May and settle on twigs and branch terminals. Growth of the scales is often completed by mid-May, at which time the females are 5-6 mm long and almost hemispherical in shape (A, C). They are a mottled brown in color. Male scales are smaller and elongate and are covered with a waxy secretion. The winged males begin emerging in late May and fertilize the fully developed females. Oviposition occurs in June. The powdery, white eggs hatch from late June to late July. The nymphs or crawlers (A, B) soon migrate to the leaves, where they feed throughout the summer. Most of the nymphs congregate on the lower surface of the leaves near the larger veins. The nymphs start to move to their hibernation sites in late August, and most have left the leaves by late September.

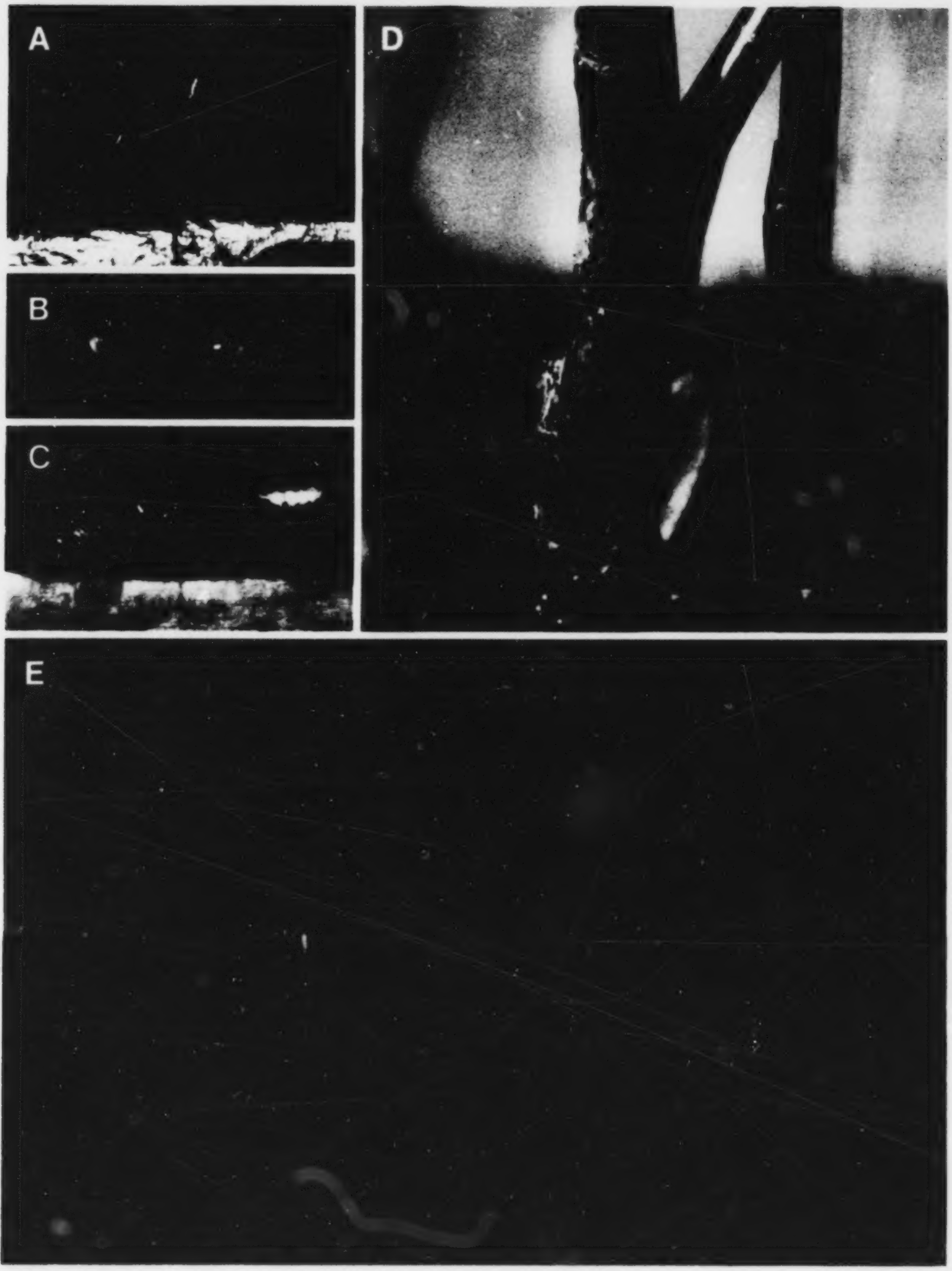
The life cycles of the three other scale insects have not been studied in detail in the prairie provinces. There is probably only one generation per year, although *Q. perniciosus* may have two. ***Chionaspis furfura*** (D) feeds on the stems and branches of its hosts. The female scales are pear shaped, whitish in color, and 2-3 mm long when fully grown. The male scales are slender and much smaller. ***Lepidosaphes ulmi*** (E) resembles a tiny oystershell and is about 3 mm long. The scales are often clustered together, and the insect overwinters in the egg stage beneath the old scales. Males are rare. ***Quadraspidiotus perniciosus*** overwinters as a partly grown nymph. Female scales (F) are gray, circular, and 1-2 mm in diameter. They are flat, with a nipple or raised area near the middle, and take about 7 weeks to reach maturity. Males are smaller and oval in shape, and they complete their development in about 3 weeks.

Damage

Light infestations of scale insects do little damage to their hosts, but large populations may weaken or kill stems and branches. Severe infestations of ***L. ulmi*** have reportedly killed stands of ash in eastern North America, but this is unusual. Damage is usually confined to individual stems and branches on small groups of trees or shrubs, especially those in shaded areas.

Bibliography: 139, 297, 392, 416, 476

Figure 105. Scale insects on hardwoods. A. Old female scales of the European fruit lecanium, *Parthenolecanium corni* (Bouché). One of the scales has been lifted to show the young nymphs underneath. **B.** *P. corni* nymph. **C.** Mature female scales of *P. corni*. **D.** Male (small) and female (large) scurfy scales, *Chionaspis furfura* (Fitch). **E.** Oystershell scale, *Lepidosaphes ulmi* (Linnaeus). **F.** San José scale, *Quadraspidiotus perniciosus* (Comstock).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THE SMALLER WILLOWSHOOT SAWFLY (Figure 106)

Distribution, Hosts, and Importance

The smaller willowshoot sawfly, ***Euura atra*** (Jurine), has a Holarctic distribution and occasionally becomes abundant in willow stooling beds in nurseries, particularly if these stools are not cut annually. *Euura atra* attacks a number of willow species, but the introduced European willows are the preferred hosts in Alberta. Infestations seem to be short-lived, however, based on the limited amount of information available.

Life Cycle and Appearance

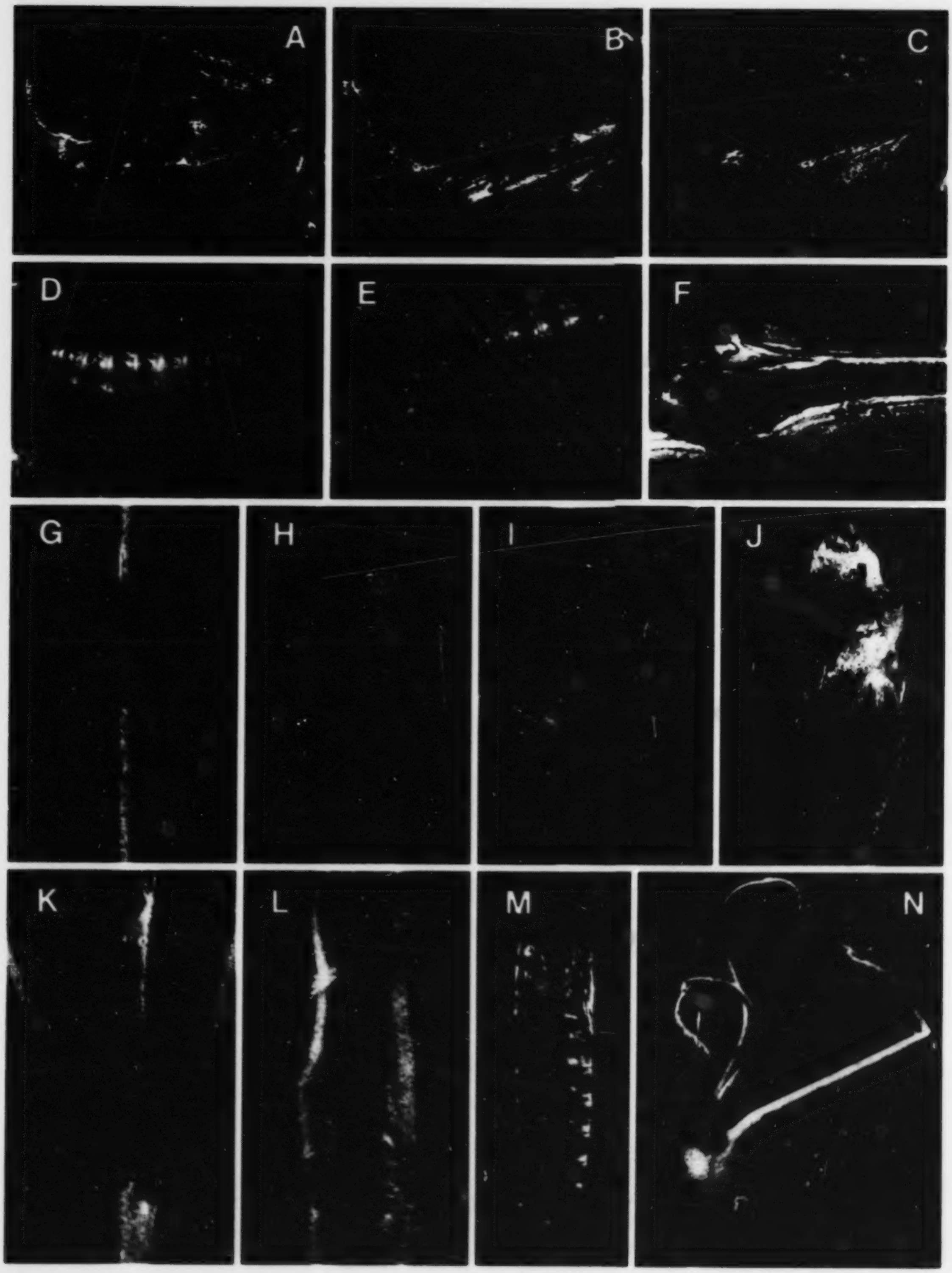
Euura atra has one generation per year. Larvae overwinter in the mined shoots of the host, usually within a thin silken cocoon. Pupation occurs in the spring, and the small, black, wasplike adults (A) emerge in late May or early June. The whitish eggs (B) are inserted into the new shoots near the pith. The larvae bore into the pith and are believed to have seven instars. Fully grown larvae have well-developed thoracic legs, are about 8 mm long, and have pale green bodies with black heads (C).

Damage

Euura atra sometimes causes severe damage to willow in stooling beds or young shelterbelts (E). Some of this damage is attributable to attacks by a fungus, *Cytospora capreae* Fuckel (D), or to excavation of the overwintering larvae by the downy woodpecker. Cuttings taken from infested stooling beds have to be checked carefully before distribution to avoid dissemination of infested stock. Infestations by this insect therefore have the double effects of reducing the number of cuttings produced and of increasing production costs because of the extra checking required.

Bibliography: 347, 650

Figure 106. The smaller willowshoot sawfly, *Euura atra* (Jurine). A. Adult. B. Egg. C. Larva in stem. D. The fungus, *Cytospora capreae* Fuckel on infested willow. E. Shelterbelt damaged by *E. atra*.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TWIG BORERS IN MANITOBA MAPLE (Figure 107)

Distribution, Hosts, and Importance

Three species of *Proteoteras* attack Manitoba maple in the prairie provinces. It was originally thought that the boxelder twig borer, ***P. willingana*** (Kearfott), was the only species boring in the twigs of boxelder in this region, but recent studies with pheromone traps have shown that two additional species are also twig borers. ***Proteoteras crescentana*** Kearfott is as common as *P. willingana* in some Manitoba maple shelterbelts in Alberta, and the same is probably true elsewhere in the region. The mapletwig borer, ***P. aesculana*** Riley, which is closely related to a species that attacks the seeds (Fig. 49), is present in smaller numbers.

None of these shoot borers are of economic importance, because Manitoba maple is seldom used in ornamental plantings.

Life Cycle and Appearance

The life cycles and appearance of all three *Proteoteras* species are very similar, and positive identification is best left to an expert. The biology of *P. willingana* has been studied in greatest detail and will be used as an example.

Proteoteras willingana adults have a wingspan of 15-20 mm and emerge in late June or early July. The front wings (A) are uniformly gray or are gray with various amounts of dark brown markings that do not form the crescent-shaped mark on the outer front edge of the wing that is characteristic of *P. crescentana*. The hind wings are gray, with a black or dark gray border along the rear edge. Eggs are laid singly on the undersurface of the leaves, usually near the midrib or a larger vein. The larvae first appear in early July. They skeletonize the underside of the leaf (G), covering themselves with frass and silk. The larvae continue to feed on the leaves until late July or early August, when they bore into the shoot (H) or bud (J). Very little feeding occurs until the following spring, and the overwintering fourth-instar larvae are smaller than the third-instar larvae that entered the shoots or buds. The larvae leave the hibernating sites (J) in early spring and burrow into a new bud, hollowing out the contents. The larvae then molt to the fifth instar and burrow into the developing shoots (I), plugging the entrance hole with frass and silk. Their feeding stimulates a noticeable swelling of the shoot. Mature larvae (D) are 10-11 mm long, and there are seven larval instars in all. The head and thoracic shield are yellowish brown at first but soon darken and become almost black. The body is cream colored or bluish gray with darker setal bases, and the anal shield is brownish.

Proteoteras crescentana adults emerge about 2 weeks later than those of *P. willingana* and have a wingspan of 16-19 mm. The front wings (B) are gray and have a distinct dark brown or black crescent on the outer front part of the wing. The crescent encloses a brownish patch. The hind wings are uniformly gray. The larvae (E) resemble those of *P. willingana*, except for setal patterns, and reach a length of about 13 mm. The larvae burrow into the shoots (K) and overwinter in the hollowed-out stem (L). The pupae (M) are light brown.

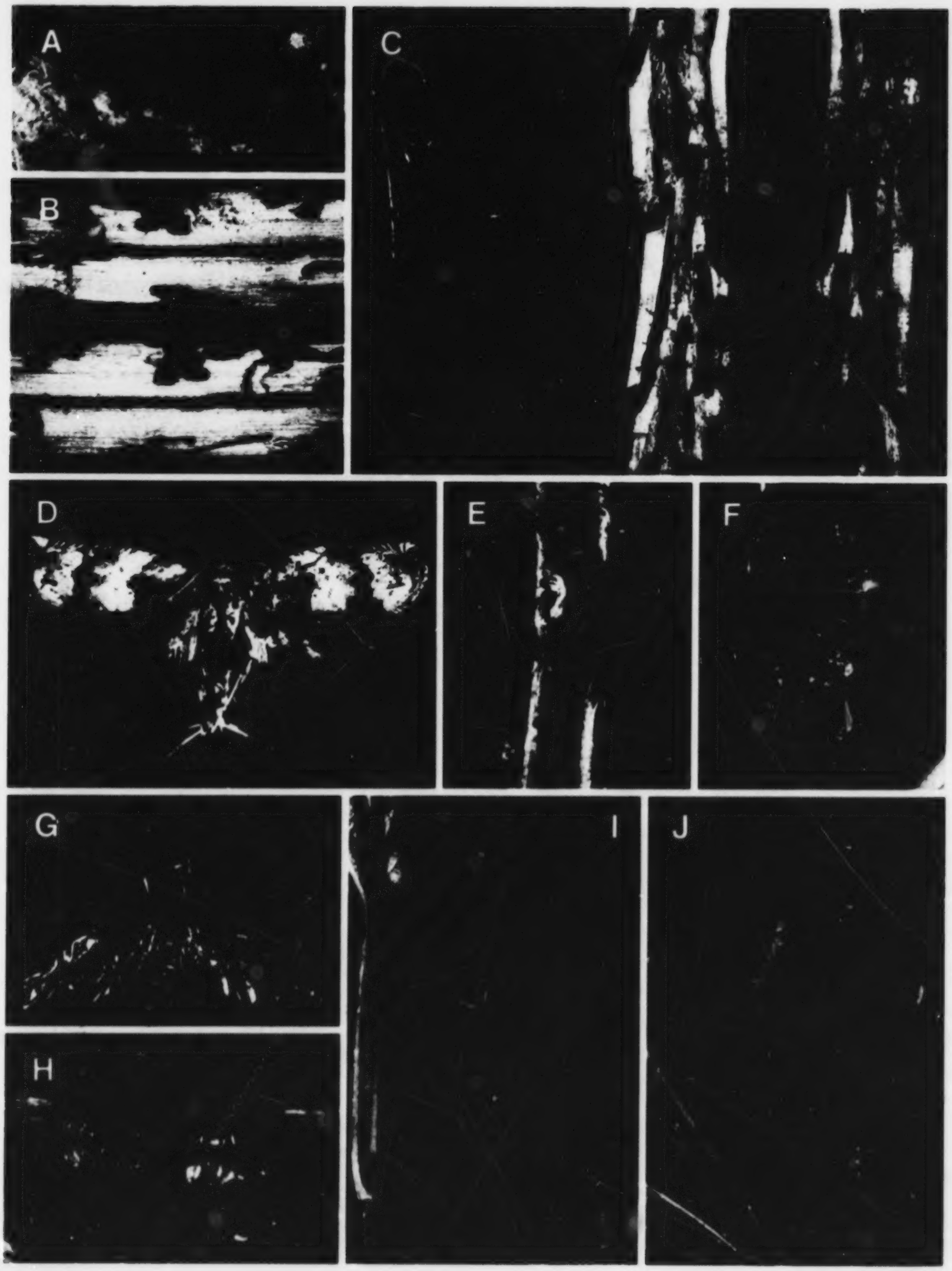
The life cycle of ***P. aesculana*** is not fully understood. The adults are smaller than the two preceeding species and have a wingspan of 11-18 mm. The front wings (C) are gray, with an olive-green cast in fresh specimens. There is an incomplete black crescent on the outer front edge of the wing, but the enclosed area is gray. The hind wings are gray and have a dark gray or black border on the rear edge. The larvae bore into the shoots (N). The boring kills the tip of the shoot and produces a noticeable swelling. The larvae of a closely related species bore into the seeds (Fig. 49). The larvae are creamy-white or bluish gray (F), have dark brown heads and thoracic shields, and are about 10 mm long at maturity. They can be separated from the other two species by the presence of an anal fork, which is visible under low magnification.

Damage

The shoot- and bud-boring habits of all three species create a bushy growth that is undesirable in ornamental plantings but is of little consequence in trees used for shelterbelts.

Bibliography: 141, 253, 351, 442, 451, 476, 646

Figure 107. Twig borers in Manitoba maple. A. Left wings of the boxelder twig borer, *Proteoteras willingana* (Kearfott). **B.** Left wings of *P. crescentana* Kearfott. **C.** Left wings of the mapletwig borer, *P. aesculana* Riley. **D.** *P. willingana* larva. **E.** *P. crescentana* larva. **F.** *P. aesculana* larva. **G.** Young *P. willingana* larva feeding on underside of leaf. **H.** *P. willingana* larva entering shoot. **I.** Manitoba maple shoot infested with *P. willingana* larva. **J.** Manitoba maple bud killed by overwintering *P. willingana* larva. **K.** Manitoba maple shoot infested with *P. crescentana* larva. **L.** Overwintering *P. crescentana* larva in shoot. **M.** *P. crescentana* pupa. **N.** Manitoba maple shoot infested with *P. aesculana* larva.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SHOOT AND STEM BORERS IN POPLAR AND WILLOW (Figure 108)

Distribution, Hosts, and Importance

The stems and shoots of poplar and willow are attacked by three different types of borers. The poplar-and-willow borer, ***Cryptorhynchus lapathi*** (Linnaeus), was probably accidentally introduced from Europe into North America during the latter part of the 19th century. It is now widely distributed across southern Canada, where it attacks willow, poplar, and occasionally alder and white birch. The cottonwood twig borer, ***Gypsonoma haimbachiana*** (Kearfott), probably occurs in the southern parts of all three prairie provinces but has only been reported from hybrid poplar in Alberta. The willow shoot sawfly, ***Janus abbreviatus*** (Say), ranges west to Saskatchewan and attacks willow and hybrid poplar.

None of these insects are of economic importance in the forest. *Cryptorhynchus lapathi* and *G. haimbachiana* are sometimes pests in ornamental plantings, and *J. abbreviatus* has caused serious damage in nursery stooling beds of poplar and willow.

Life Cycle and Appearance

Cryptorhynchus lapathi probably requires 2 years to complete its life cycle in most of the prairie provinces, but 3 years may be needed at higher elevations or in northern areas. Overwintering occurs as first-instar larvae and as adult beetles. Some adults may overwinter twice, but it is not clear whether or not they subsequently produce viable eggs.

Adult *C. lapathi* (A) are stout weevils with long curved snouts and are 8–10 mm long. They have functional wings but rarely fly. The beetle has a number of erect black bristles on its body and is densely covered with black and light-colored scales. The latter are pinkish at first but gradually fade and form an irregular band across the ends of the elytra and on the ventral area of the prothorax. The curved snout fits into a groove when the insect is at rest. The adults are heavy feeders, preferring the young shoots. Oviposition occurs during the summer in deep holes chewed by the females in the bark on the lower part of the stems. A single egg is usually deposited in each hole, but two or three are sometimes laid. The young larvae burrow in the bark at first, then enter the wood (B), where they excavate extensive, meandering tunnels (C), pushing the borings to the outside of the stem. The larvae are creamy-white, C-shaped, legless grubs that reach a length of about 13 mm when mature.

Gypsonoma haimbachiana probably has one generation per year in the prairie provinces and overwinters as tiny larvae in silk-covered hibernacula in niches chewed into the rough bark of shoots or in other sheltered areas on the tree. The larvae emerge from hibernation in late May or early June and tunnel into the new growth, expelling frass to the outside (F). There are five larval instars, and mature larvae (E) are 12-15 mm long. They have brown heads, brownish thoracic shields, and pale bodies. The adults (D) have a wingspan of about 15 mm and emerge during the summer. The front wings are ash gray and have two irregular dark bands. The hind wings are gray. Eggs are usually laid singly on the upper leaf surface near a vein. The newly hatched larvae move to a vein or the midrib, cover themselves with frass and silk, then tunnel into the vein or midrib. The larvae feed for a short period, then molt and move to the hibernation sites.

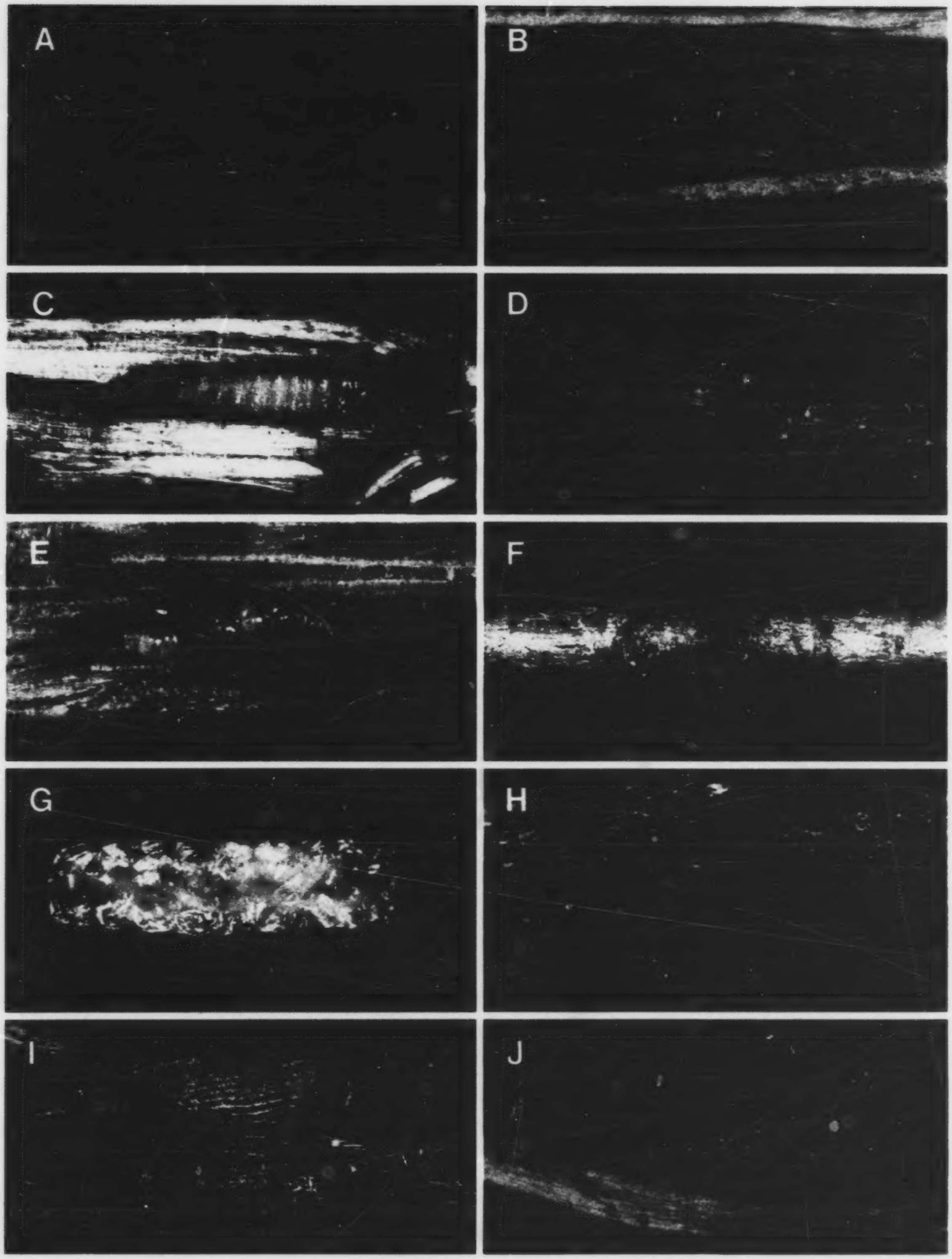
Janus abbreviatus has one generation per year in this region and overwinters as larvae in cocoons spun within the shoots. The adults (G) are delicate sawflies that emerge in late spring or early summer. Females have a sawlike ovipositor and a wingspan of 12–16 mm. Males are smaller and have a wingspan of 10–12 mm. The head and thorax are black, and the abdomen is black with a brownish band. The females often girdle the shoot above the oviposition site, killing it (I, J) or weakening it. The larvae (H) tunnel down the shoot and are creamy-white with a pale yellow head. The body is S-shaped, with a small spine at the end of the abdomen. The larvae have rudimentary thoracic legs, but no prolegs, and reach a length of 8–11 mm.

Damage

The feeding by ***C. lapathi*** larvae weakens the stems of willows and sometimes poplars, making them susceptible to breakage during high winds or ice storms. Such damage is of most concern in ornamental plantings. ***Gypsonoma haimbachiana*** has the potential of being a serious pest of hybrid poplars, causing bushy, deformed growth, but only isolated infestations have as yet been recorded. ***Janus abbreviatus*** occasionally weakens willow and hybrid poplar stools in nurseries and may drastically reduce the yields of cuttings. Care must be exercised to avoid the distribution of infested cuttings containing the overwintering larvae.

Bibliography: 139, 202, 241, 371, 418, 476, 520, 541

Figure 108. Shoot and stem borers in poplar and willow. A. Adult poplar-and-willow borer, *Cryptorhynchus lapathi* (Linnaeus). **B.** *C. lapathi* larvae. **C.** Stem showing external symptoms of *C. lapathi* feeding, and another stem split open to show internal damage. **D.** Adult cottonwood twig borer, *Gypsonoma haimbachiana* (Kearfott). **E.** *G. haimbachiana* larva. **F.** External symptoms of *G. haimbachiana* damage. **G.** Willow shoot sawfly, *Janus abbreviatus* (Say). **H.** *J. abbreviatus* larva. **I.** Hybrid poplar shoot girdled by ovipositing *J. abbreviatus* female. **J.** Willow shoot girdled by ovipositing *J. abbreviatus* female.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SHOOT AND BRANCH BORERS IN POPLAR AND WILLOW (Figure 109)

Distribution, Hosts, and Importance

Three species of roundheaded wood borers breed in the stems and branches of poplar and willow in the prairie provinces. The poplar branch borer, ***Oberea schaumi*** LeConte, attacks the stems and branches of young poplar and the branches of larger trees. The poplar gall borer, ***Saperda populnea moesta*** LeConte, breeds in the small stems and branches of balsam poplar and trembling aspen. The poplargall saperda, ***S. concolor*** LeConte, attacks small-diameter poplar and willow in Manitoba and Saskatchewan. There has been some taxonomic confusion concerning this insect, which is also referred to in the literature as *S. inornata* Say.

Agrilus criddlei Frost is a flatheaded wood borer that is known to breed in Bebb or beaked willow, but it may also attack other willow species. ***Poecilonota cyanipes*** (Say) is another flatheaded wood borer that attacks injured trembling aspen and willow. It sometimes breeds in the stem galls formed by *S. concolor*.

All of these insects occur throughout the region unless otherwise noted, but none are of economic importance.

Life Cycle and Appearance

The three roundheaded wood borers all have similar life cycles in the prairie provinces. More than 1 year is required to complete their development. The larvae are whitish or yellow, legless grubs with brown heads, and the adults are slender, cylindrical beetles with long antennae. ***Oberea schaumi*** adults (A) are the largest of the group, measuring 13-16 mm in length. The head may vary in color from orange to nearly black, the prothorax is orange with two black spots, and the elytra are brownish black and are covered with short silvery hairs. The underside of the body is mostly orange. Eggs are laid singly in notches chewed in the bark by the females. The larvae (B) tunnel into the pith and require 3 years to complete their development. Accumulated debris is expelled through holes that are bored to the outside in early fall. Mature larvae are about 25 mm long.

Saperda populnea moesta adults (not shown) are black and are 9-11 mm long. The larvae (C) probably require 2 years to complete development and are about 15 mm long when mature. Their feeding produces a noticeable swelling of the stem (D). ***Saperda concolor*** adults (not shown) are black with gray hairs and are 7-11 mm long. The females cut U-shaped notches into the bark and deposit a single egg at the bottom of each before sealing the whole notch with a brown fluid. An average of three notches are cut into each stem that is attacked. The larvae hatch in about 2 weeks and feed initially in the cambial areas under the scar. The larvae then burrow into the wood (E) and expel the frass to the outside through the egg scars (F). Development is usually completed in 2 years. Feeding damage initially produces only a slight swelling in the injured area, but continued growth may eventually produce large, persistent galls.

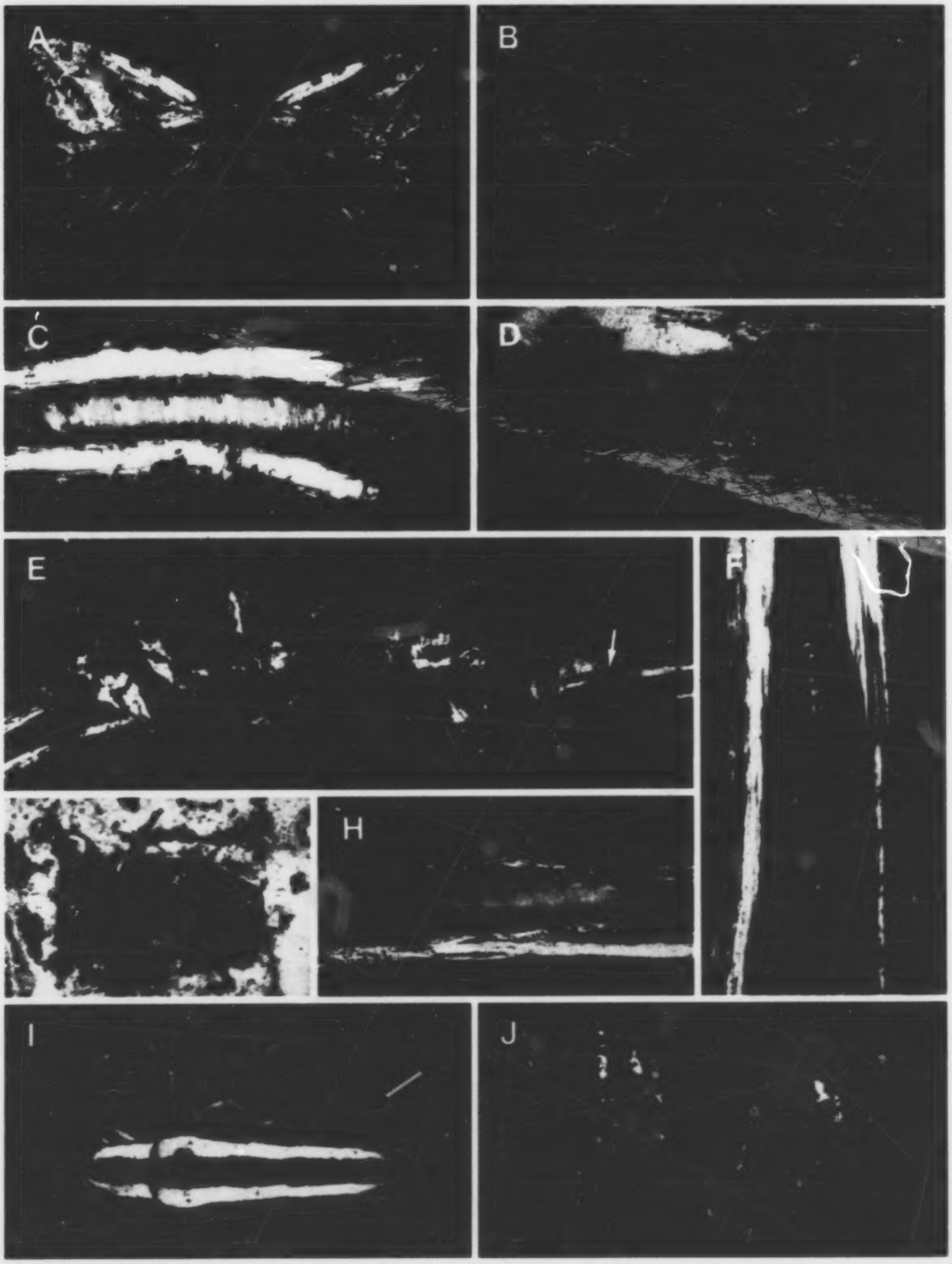
The life cycles of the two flatheaded wood borers are not fully understood, but both species probably require 2 years to complete development, and the adults emerge during the summer. ***Agrilus criddlei*** adults (not shown) are slender greenish bronze beetles, with a bluish metallic luster, and have relatively long antennae. They resemble the bronze birch borer, *A. anxius* Gory (Fig. 112), in general appearance but are only about 7.5 mm long. The larvae (G) reach a length of about 12 mm and are creamy-white, legless grubs with brown heads. They lack the broad, flat thorax characteristic of many flatheaded wood borer larvae and have two chitinous projections at the rear of the abdomen. Larval feeding stimulates the formation of a gall (H) on the affected stem. ***Poecilonota cyanipes*** adults (I) are a dark copper-gray in color and are 10-18 mm in length. The apexes of the elytra are prolonged and reddish. The larvae (J) are typical flatheaded wood borers and have a broad, flattened thorax and a slender, segmented abdomen. They are legless and have brown heads and creamy-white bodies. Mature larvae are 25-40 mm long.

Damage

The feeding of these wood-boring larvae may occasionally weaken the stems, so that breakage occurs at the point of injury. The damage is of little concern under forest conditions, although the insects provide entry courts for disease organisms. Aspen-infesting species may therefore be more important than is currently realized, should the utilization of aspen increase.

Bibliography: 139, 169, 198, 203, 257, 272, 315, 368, 395, 434, 476, 609

Figure 109. Shoot and branch borers in poplar and willow. A. Adult poplar branch borer, *Oberea schaumi* LeConte. **B.** *O. schaumi* larva. **C.** Poplar gall borer, *Saperda populnea moesta* LeConte, larva. **D.** Gall on balsam poplar caused by *S. populnea moesta* larva. **E.** Poplargall saperda, *S. concolor* LeConte, larva. **F.** Trembling aspen shoot infested with *S. concolor* larva. **G.** *Agrilus criddlei* Frost larva. **H.** *A. criddlei* gall on willow. **I.** Adult *Poecilonota cyanipes* (Say). **J.** *P. cyanipes* larva.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ROOT AND BASAL-STEM BORERS OF HARDWOODS (Figure 110)

Distribution, Hosts, and Importance

In addition to beetle larvae, the larvae of three closely related species of ghost moths of the genus *Sthenopis* bore into the roots and basal stems of hardwoods in the prairie provinces. ***Sthenopis quadriguttatus*** (Grote) attacks trembling aspen and willow, and the alder root borer, ***S. argenteomaculatus*** (Harris), and ***S. purpurascens*** (Packard) attack alder and probably balsam poplar.

Larvae of the poplar borer, ***Saperda calcarata*** Say, bore in the stems of open-grown poplars (Fig. 114) but are also found in the basal stem and adjacent roots of young trembling aspen and balsam poplar, especially on poor sites. The flatheaded apple tree borer, ***Chrysobothris femorata*** (Olivier), attacks a wide variety of hardwood hosts, and the larvae have been found feeding near the ground in the basal stems of young trembling aspen suckers in north-central Saskatchewan. The roundheaded apple tree borer, ***Saperda candida*** Fabricius, is primarily a pest of apple, but it also attacks the base of mountain-ash, hawthorn, and saskatoon in southeastern Manitoba.

All of these insects occur throughout the region unless otherwise noted, but none are currently of economic importance. *Sthenopis quadriguttatus* may be of more importance than is currently realized, especially if trembling aspen is utilized more extensively than at present.

Life Cycle and Appearance

All three species of *Sthenopis* are believed to have similar life cycles. Development probably requires at least 2 years, and the adults emerge in midsummer. ***Sthenopis argenteomaculatus*** adults (A) have a wingspan of 65-100 mm. The front wings are mouse colored and have darker bands and two or more silver spots near the base. The hind wings of males are mouse gray, with brownish tips, and those of the females are straw yellow, with brownish borders. The larvae (C) are slender and cylindrical and reach a length of 50-60 mm when mature. They have brown heads, creamy-white bodies with brown setal bases, and fully developed prolegs and thoracic legs. The active larvae excavate extensive galleries in larger roots. The wood chips are removed from the tunnels and are packed around the silk-lined galleries in the soil. Galleries in small roots are much less extensive and appear to serve as refuges only. The pupae are slender and brown in color, and they wriggle to the surface just prior to adult emergence. The adults fly at dusk, and the females lay their eggs indiscriminately in the vicinity of their hosts. ***Sthenopis purpurascens*** adults are very similar to those of *S. argenteomaculatus*, but the front wings are usually suffused with yellowish brown, and the hind wings are tinged with rose. ***Sthenopis quadriguttatus*** adults (B) have yellowish brown front wings with darker markings, and the hind wings are salmon colored.

Saperda calcarata breeding in the basal stem and roots of poplars were once thought to be a subspecies, distinct from the stem-inhabiting form (Fig. 114), but this distinction does not appear to be warranted. The habits of the root-inhabiting form will be discussed briefly. The adults emerge during the summer and are grayish black and densely covered with fine gray or yellow hairs. They are 20-30 mm long. Young larvae (D) are creamy-white, legless grubs with brown heads. They tunnel extensively under the bark, expelling frass through holes chewed through the bark. Mature larvae reach a length of 40-50 mm and overwinter in frass-plugged tunnels in the stem (F). Completion of the life cycle requires 3 years.

The life cycle of ***C. femorata*** has not been studied in this region. Development is completed in 1 year in warmer climates, but 2 years may be required in the prairie provinces. The adults (G) emerge during the summer. They are oval in shape, are a dark greenish bronze in color, and are 9-16 mm long. Eggs are laid in bark crevices. The legless larvae (H) feed in the phloem and sapwood, excavating extensive tunnels. They have brown heads and creamy-colored bodies. The first thoracic segment is broad and flattened, and mature larvae are 25-30 mm long.

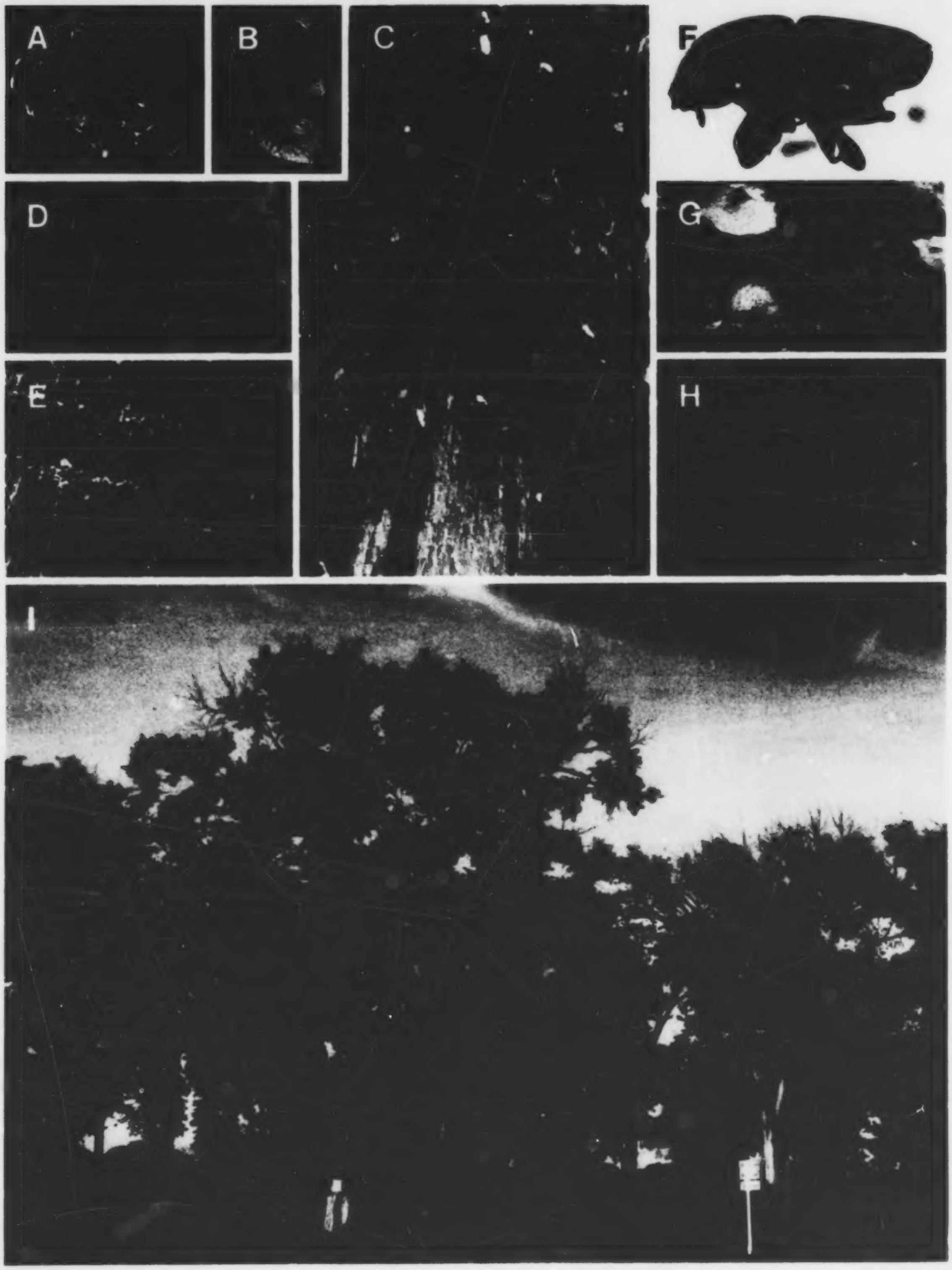
The life cycle and habits of ***S. candida*** are almost identical to the form of *S. calcarata* discussed herein, except that different hosts are attacked. The adults (I) are light brown above, with two broad, white stripes extending the length of the body, and are about 20 mm long. The larvae (J) are whitish or yellowish, legless grubs that reach a length of about 40 mm at maturity.

Damage

The tunneling of these larvae (C-F, H) provides entry courts for disease organisms. Repeated attacks by ***S. calcarata*** cause swollen bases to form on young poplars, but such damage is primarily confined to trees growing on poor sites and is of little importance. Similar damage by ***S. candida*** may occasionally occur on ornamentals, however, and may kill the affected trees. ***Chrysobothris femorata*** larval feeding occasionally appears to be a factor in the death of young aspen suckers.

Bibliography: 64, 139, 145, 186, 203, 229, 297, 476

Figure 110. Root and basal-stem borers of hardwoods. A. Adult alder root borer, *Sthenopis argenteomaculatus* (Harris). **B.** Adult *S. quadriguttatus* (Grote). **C.** *S. argenteomaculatus* larva. **D.** Young poplar borer, *Saperda calcarata* Say, larva. **E.** Balsam poplar damaged by *S. calcarata* and *Sthenopis argenteomaculatus* (at arrows). **F.** Hibernating *Saperda calcarata* larva. **G.** Adult flatheaded apple tree borer, *Chrysobothris femorata* (Olivier). **H.** *C. femorata* larva. **I.** Adult roundheaded apple tree borer, *S. candida* Fabricius. **J.** *S. candida* larva.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ELM BARK BEETLES (Figure 111)

Distribution, Hosts, and Importance

Two species of bark beetles are vectors of Dutch elm disease in North America. The distribution of the native elm bark beetle, ***Hylurgopinus rufipes*** (Eichhoff), closely approximates the range of white elm, its principal host. It also attacks Siberian elm. The smaller European elm bark beetle, ***Scolytus multistriatus*** (Marsham), is an introduced species that is gradually spreading westward. Adult beetles have been trapped in Manitoba and Saskatchewan, but no breeding populations have been discovered. Adults feed on healthy elms, and if they are contaminated with the fungus, *Ceratocystis ulmi* (Buisman) C. Moreau, the pathogen causing Dutch elm disease, it is transmitted to the healthy trees. Apart from limited transmission by root grafts, the beetles are the sole agents responsible for spreading the disease. It is believed that campers have been a factor in hastening the spread of the disease either by the unwitting transport of infected adults or by carrying beetle-infested elm firewood to uninfested areas.

Life Cycle and Appearance

Hylurgopinus rufipes has two generations per year in warmer parts of its range but usually has one generation per year in the prairie provinces. Most of the population overwinters as adults, and the remainder overwinter as larvae. The adults are small, dark brown to black beetles between 2.0 and 3.5 mm long (A). The overwintering adults emerge from the brood trees in the fall and fly to the base of healthy elms, where they excavate overwintering tunnels. They reemerge the following spring or summer and feed briefly in the bark of healthy elm branches before flying to dead or dying elms to excavate brood galleries, which are formed across the grain (C, D). The galleries are broadly V-shaped, but there is considerable divergence from this pattern, especially if many are crowded together. Eggs are deposited in niches along both sides of the galleries (E). The larvae are white, legless grubs with pale yellowish brown heads (B). They construct galleries that fan out at right angles from the egg galleries (C). Beetles that overwinter as larvae resume development in the spring and emerge as adults in late June or July. They feed on living elms, then lay eggs in dead or dying elms.

Scolytus multistriatus overwinters in the larval stage and emerges as an adult in the spring or early summer. The adults are small, reddish brown or black beetles, usually less than 3 mm long (F). The rear end of the abdomen is concave on the underside and has a prominent projection. The adults feed on the crotches of small twigs on healthy elms, where they often penetrate into the cambial area. They excavate egg galleries parallel to the grain of the wood (G) in weakened or dying elms. The larvae are similar in appearance to those of *H. rufipes*. Their galleries also fan out at right angles to the egg gallery (G). It is not known whether these beetles can survive the cold prairie winters, but some may.

Damage

The first signs of Dutch elm disease are wilting of foliage and yellow flagging on individual branches (H, I). The disease also causes a brown ring to form under the bark on infected branches. Other diseases produce similar symptoms, however, and positive diagnosis can only be made by properly trained personnel with laboratory facilities. Dutch elm disease has decimated most white elm stands in eastern Canada and is now widely distributed in Manitoba.

Bibliography: 5, 10, 139, 258, 263, 265, 299, 316, 359, 449, 471, 516

Figure 111. **Elm bark beetles. A.** Adult native elm bark beetle, *Hylurgopinus rufipes* (Eichhoff). **B.** *H. rufipes* larva. **C.** *H. rufipes* adult and larval galleries. **D.** *H. rufipes* adult galleries. **E.** *H. rufipes* adult gallery and eggs. **F.** Adult smaller European elm bark beetle, *Scolytus multistriatus* (Marsham). **G.** *S. multistriatus* adult and larval galleries.* **H.** Early symptoms of Dutch elm disease. **I.** White elms infected with Dutch elm disease.

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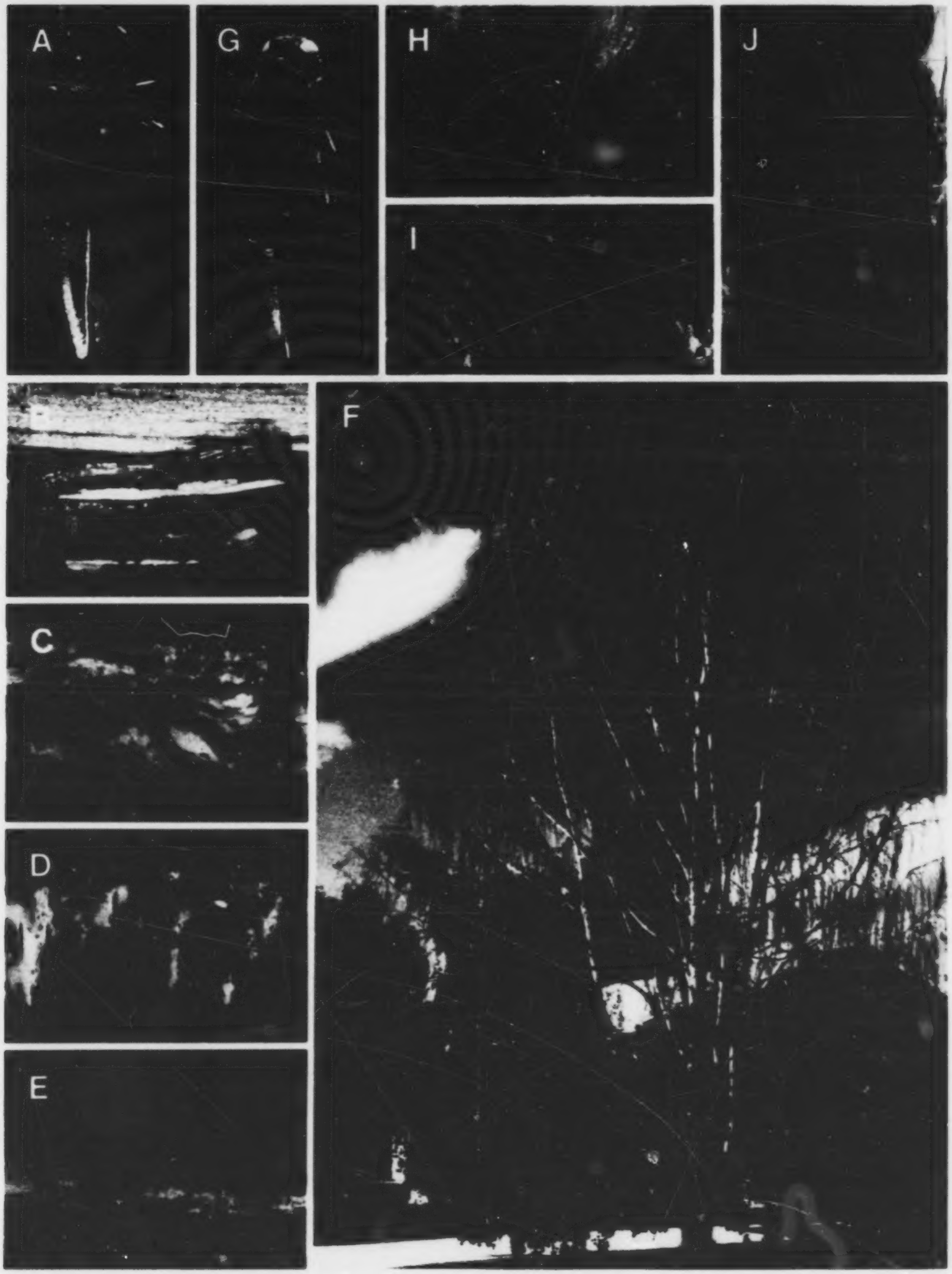
* Photograph courtesy of Great Lakes Forestry Centre.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THE BRONZE BIRCH BORER AND ITS ALLIES (Figure 112)

Distribution, Hosts, and Importance

The bronze birch borer, ***Agrilus anxius*** Gory, is probably the most serious pest of ornamental birch plantings in the prairie provinces. Young trees are not usually affected unless recently transplanted, but its effect on mature trees growing under stress can be devastating. Various birches are attacked, but native and European white birches are the principal hosts in this region.

The bronze poplar borer, ***A. liragus*** Barter & Brown, has been confused with *A. anxius*, and early reports of the latter species on poplar refer to this insect. It also affects trees growing under stress, particularly those severely affected by drought, defoliation, or disease. Trees repeatedly defoliated by the forest tent caterpillar, *Malacosoma disstria* Hübner (Fig. 71), are particularly vulnerable. *Agrilus liragus* occurs throughout the region but has not been thought of as a pest because trembling aspen has been underutilized. The recent trend towards greater utilization of aspen may change this attitude, and greater attention may have to be given to the damage caused by *A. liragus*.

A third species, ***A. granulatus*** Say, is occasionally a pest in poplar shelterbelts suffering from drought or winter injury.

Life Cycle and Appearance

Agrilus anxius probably requires 2 years to complete its life cycle in most of the prairie provinces, although the progeny of adults that emerge early in the season may only require 1 year if the summer is hot. The adults (A) begin to emerge in late June and have a life-span of about 3 weeks. Active beetles are present in the field until August. The beetles are olive green to black and have metallic bronze reflections. They are slender, more or less cylindrical, and 6–11 mm long. The females are strong fliers and search actively for suitable oviposition sites in bark crevices of weakened or dying trees, usually on the sunny side of open-growing trees. Branches about 25 mm in diameter are usually attacked first, but larger branches and the trunk are eventually infested as the trees become weaker. Eggs are deposited singly or in small groups. The legless larvae hatch in about 2 weeks and burrow directly into the cambial area. There are five larval instars, and mature larvae (B) are about 35 mm long. They have brown heads that are deeply embedded into the prothorax, which is only slightly widened. The slender creamy-white bodies have prominent segmentation and bear a pair of chitinized caudal spines. The larvae excavate meandering tunnels in the phloem (C), entering the wood periodically to molt. The final-instar larva excavates a pupal cell in the sapwood, just below the bark. Trees that are growing vigorously bridge the larval tunnels with new phloem tissue, producing a noticeable series of bumps (D). The adults chew D-shaped emergence holes through the bark (E).

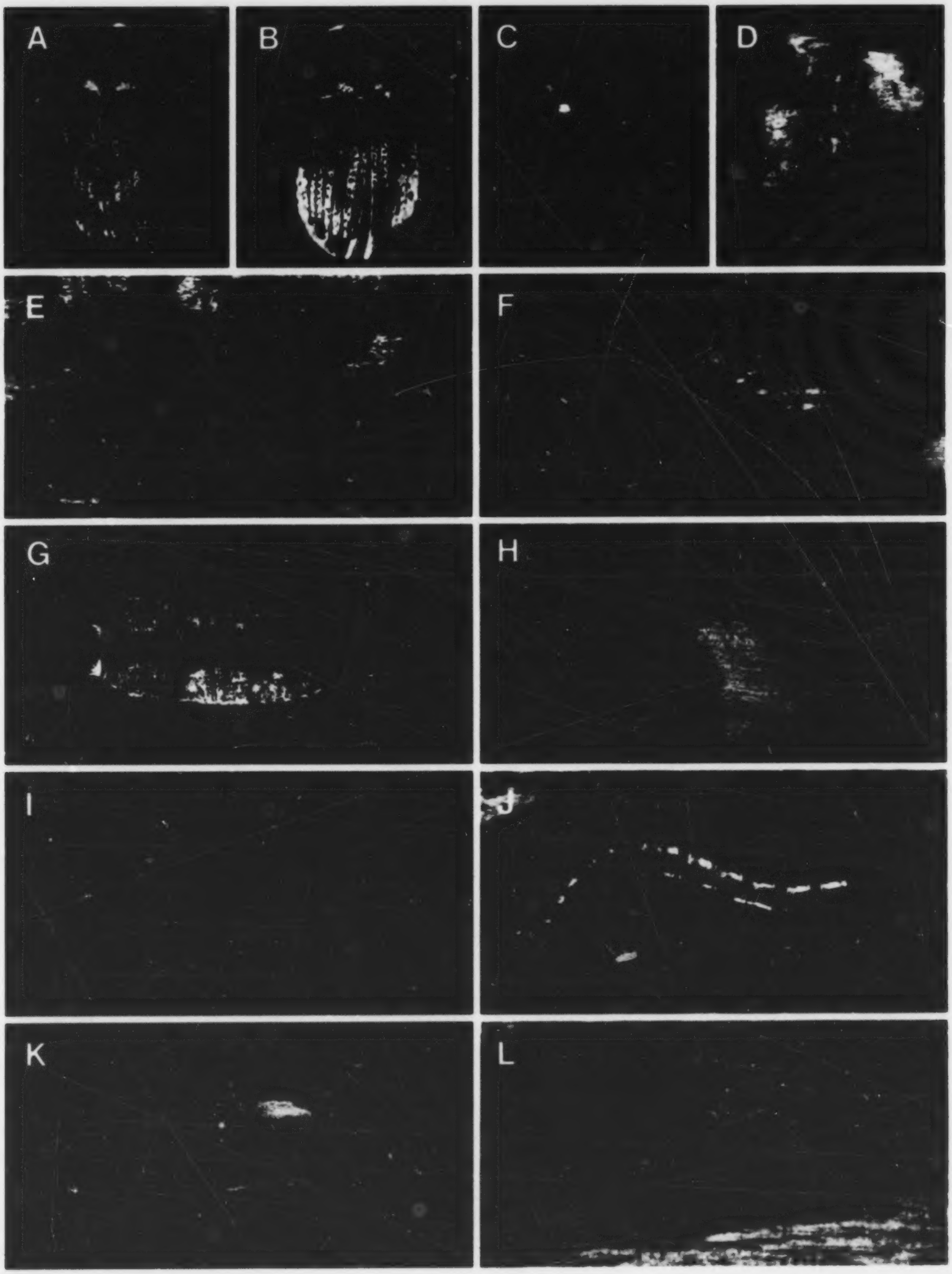
Agrilus liragus has a life history similar to that of *A. anxius*. Two years are probably required to complete development in the prairie provinces. The adults (G) begin to emerge in early June, about 2 weeks before *A. anxius* adults, which they closely resemble. The metallic bronze sheen of *A. liragus* adults is less pronounced than that of *A. anxius* adults, but the host is the simplest method for separating the two species. The adults feed on aspen foliage and live for 3–5 weeks. The males seek out suitable hosts and wait for the females to arrive. Oviposition begins 6–10 days after the females emerge, and groups of five to eight or more eggs are laid in bark crevices. The eggs hatch in about 2 weeks, and the young larvae burrow into the cambial area. They are slender (H) and have the same characteristics as *A. anxius* larvae. The larvae excavate closely spaced, zigzag galleries in the phloem, working towards the base of the tree (J). They also penetrate the wood to molt and excavate pupal cells in the sapwood. There is no external evidence of the galleries, as no bark swelling occurs. The adults emerge through D-shaped holes chewed in the bark (I). Little is known about the life history of ***A. granulatus***. It is probably similar to the above, and bumps are known to form over the galleries on young trees.

Damage

Light infestations of ***A. anxius*** kill the upper branches of the affected birch trees, but severe infestations (F) may kill the entire tree. ***Agrilus liragus*** may gradually kill affected poplar trees, especially during periods of drought, and its feeding provides an entry court for disease organisms.

Bibliography: 8, 15, 21, 22, 23, 139, 183, 203, 368, 476

Figure 112. **The bronze birch borer, *Agrilus anxius* Gory, and its allies. A.** Adult *A. anxius*. **B.** *A. anxius* larva. **C.** *A. anxius* larval galleries. **D.** Bumps on birch branch caused by phloem growth over *A. anxius* larval galleries. **E.** D-shaped *A. anxius* adult emergence holes. **F.** Weeping birch tree dying as a result of *A. anxius* attack. **G.** Adult bronze poplar borer, *A. liragus* Barter & Brown. **H.** *A. liragus* larva. **I.** *A. liragus* adult emergence hole. **J.** *A. liragus* larval galleries.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ASH BARK BEETLES AND MINOR WOOD BORERS IN HARDWOODS (Figure 113)

Distribution, Hosts, and Importance

Three species of bark beetles in the genus *Hylesinus* attack ash trees in the prairie provinces. The eastern ash bark beetle, ***H. aculeatus*** (Say), and Criddle's bark beetle, ***H. criddlei*** (Swaine), are eastern species whose ranges extend into Manitoba. They attack newly cut, recently dead, or dying trees and are of no economic importance. The western ash bark beetle, ***H. californicus*** (Swaine), occurs in southern Alberta, Saskatchewan, and southern Manitoba. It is occasionally a serious pest of newly planted trees and trees growing under stress during periods of drought.

Numerous species of wood-boring beetles breed in dead and rotting hardwoods, but none are of economic importance. Three examples will be discussed briefly. ***Dicerca hesperoborealis*** Hatch & Beer is a western species that breeds in alder and white birch in Alberta. The roughened darkling beetle, ***Upis ceramboides*** (Linnaeus), is occasionally found in white birch and trembling aspen throughout the region. Adults of the tribe Lepturini are often seen on various flowers. The larvae are found primarily in decaying conifers, but ***Trigonarthris proxima*** (Say) and ***Trachysida mutabilis*** (Newman) are also found in decaying white birch.

Life Cycle and Appearance

The three *Hylesinus* species have similar life cycles and habits, except that only *H. californicus* is capable of killing healthy trees. All have one generation per year in the prairie provinces and overwinter as adults in hibernation chambers excavated in the rough outer bark on the trunk of the host trees. ***Hylesinus aculeatus*** adults (A) are 2.1-3.0 mm long and have dense scales on the pronotum and elytra. The white scales on the pronotum outline a diamond-shaped patch of dark brown or dark reddish brown scales. The brown and white scales on the elytra form a variable herringbone pattern. ***Hylesinus californicus*** adults (B) also have a variable herringbone pattern on the elytra. They are 2.6-3.0 mm long and resemble *H. aculeatus* adults. The apparent difference in the herringbone patterns on the two specimens shown (A, B) is not consistent due to the variability in the markings of each species. ***Hylesinus criddlei*** adults (not shown) resemble those of *H. aculeatus* but tend to be smaller, ranging from 2.0 to 2.6 mm in length. Identification is best left to the expert.

Hylesinus californicus adults emerge from hibernation in late May or early June. The adults excavate egg galleries (C) around the twigs or branches and occasionally the trunk, chewing ventilation holes through the bark at frequent intervals. Eggs are laid in niches (D) along each side of the galleries. The larvae (E) are small, white, legless grubs with brown heads. Their galleries (F) are roughly parallel to the grain of the wood, which is scored deeply. Adults begin to emerge in mid-August, and some excavate egg galleries, but it is not known if the resultant larvae survive the winter. Most adults apparently construct overwintering galleries without excavating any egg galleries. The life cycles of ***H. aculeatus*** and ***H. criddlei*** are similar to that of *H. californicus*, but the adults do not chew ventilation holes when excavating the egg galleries.

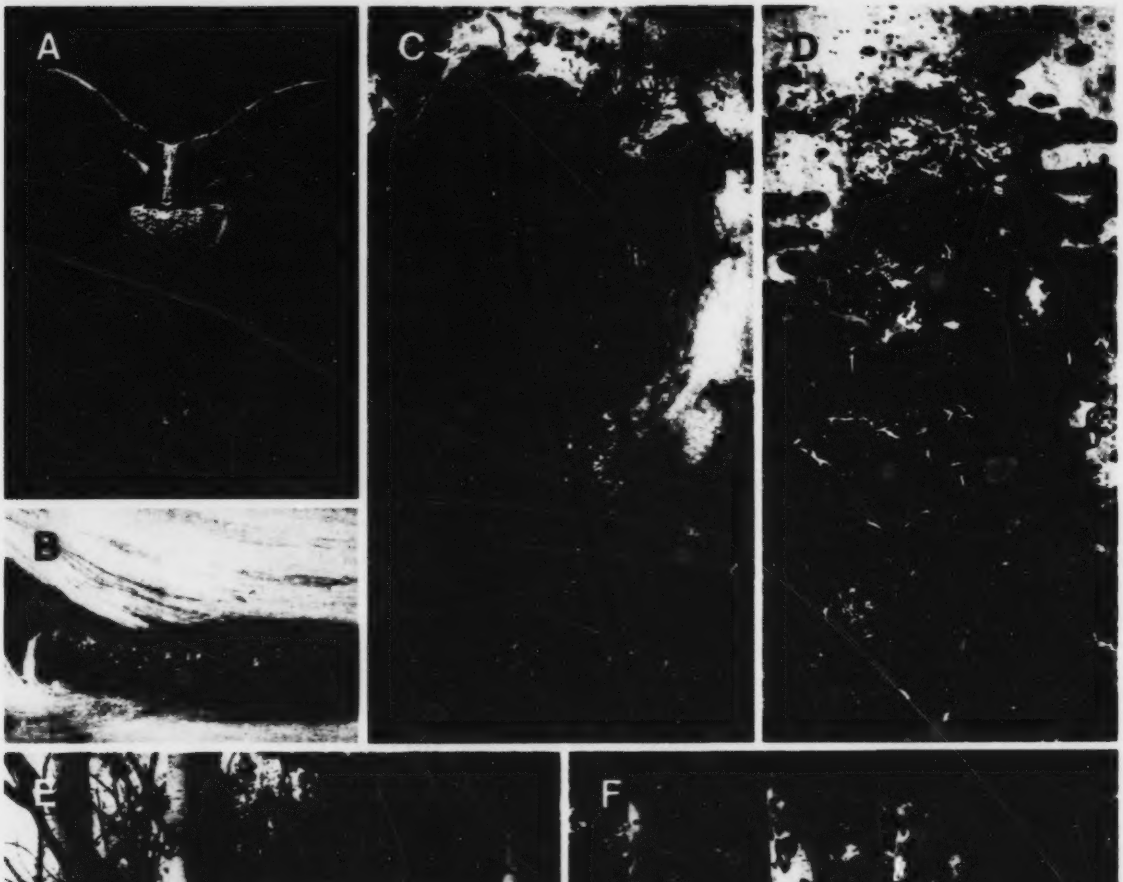
The life cycles of the three groups of wood-boring beetles are not well known, but all probably require 2 years to complete their development. ***Dicerca hesperoborealis*** adults (G) emerge in midsummer and are 17-20 mm long. They are shiny, copper-colored, stout-bodied beetles. The tips of the elytra are elongated and reddish. The larvae (H) are legless and reach a length of about 40 mm. The body is whitish and has a flattened thorax, and the head is dark brown. Larval galleries are found in dead but still sound wood. ***Upis ceramboides*** adults (I) overwinter under loose bark or under other shelter. They are black, have heavily sculptured elytra, and are 14-19 mm long. The larvae (J) resemble plump, shiny wireworms. They have brown heads, light brown thoraxes, and yellowish bodies with two anal hooks. They reach a length of about 30 mm and feed on the decayed inner bark of white birch or in the moist, rotted wood of trembling aspen. ***Trigonarthris proxima*** adults (K) emerge during the summer, have black legs, antennae, heads, and thoraxes, and are about 20 mm long. The elytra are sharp shouldered and are brownish in color with black tips. The larvae (L) reach a length of about 25 mm and have whitish bodies and brown heads. They have rudimentary thoracic legs and conspicuous body segments; each segment bears numerous small, dorsal papillae. ***Trachysida mutabilis*** adults (not shown) are 8-13 mm long. Some resemble *Trigonarthris proxima* in color, and others are entirely black.

Damage

Hylesinus californicus initially attack and kill small twigs and branches, but as the tree becomes weaker they may attack larger branches and eventually the bole of the tree. ***Hylesinus aculeatus*** and ***H. criddlei*** may breed in branches already killed by *H. californicus* but are not capable of killing the trees.

Bibliography: 61, 97, 133, 139, 203, 207, 244, 245, 393, 565, 568

Figure 113. Ash bark beetles and minor wood borers in hardwoods. A. Eastern ash bark beetle, *Hylesinus aculeatus* (Say). **B.** Western ash bark beetle, *H. californicus* (Swaine). **C.** Green ash twig girdled by *H. californicus* adult gallery. **D.** Bark removed from green ash twig to expose *H. californicus* adult gallery. Eggs are deposited singly in niches along each side of gallery. **E.** *H. californicus* larvae. **F.** *H. californicus* larval galleries. **G.** Adult *Dicerca hesperoborealis* Hatch & Beer. **H.** *D. hesperoborealis* larva. **I.** Roughened darkling beetle, *Upis ceramboides* (Linnaeus). **J.** *U. ceramboides* larva. **K.** Adult *Trigonarthris proxima* (Say). **L.** Lepturini larva (possibly *T. proxima*) in trembling aspen.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THE POPLAR BORER (Figure 114)

Distribution, Hosts, and Importance

The poplar borer, ***Saperda calcarata*** Say, is an important pest of trembling aspen. It also attacks the root crown and lower stem of young trembling aspen and balsam poplar growing on poor sites (Fig. 110) and will occasionally attack other poplar species and willows. Open-growing trees, or those growing around the edges of bluffs, seem to be most vulnerable to attack. The insect is particularly troublesome in the aspen parkland, where up to 75% of trees 7–10 cm in diameter have been infested. The insect also occurs in forested areas but is not usually considered to be a problem, primarily because so little aspen is utilized.

Life Cycle and Appearance

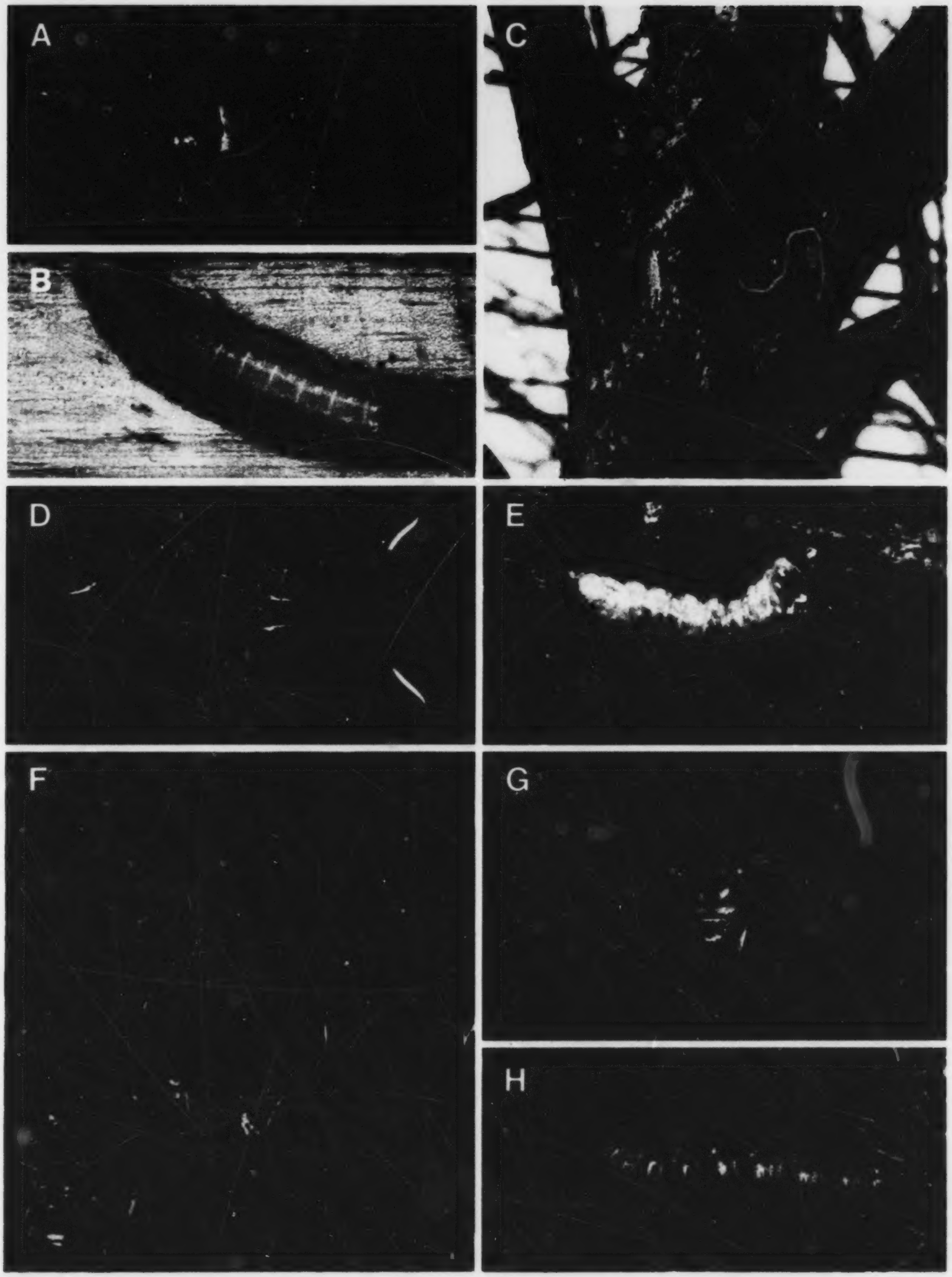
The poplar borer has a long life cycle. Most individuals require 4 years to complete development, but this period may vary from 3 to 5 years. The adult beetles (A) are about 25 mm long, as are the antennae. The ventral parts of the beetle are gray. The dorsum is also basically gray, with faint yellow stripes on the thorax and yellow blotches on the elytra, all densely stippled with small brown dots. The adults emerge in late June and July and live for up to 6 weeks. They feed on aspen and willow foliage and begin laying eggs about 1 week after emergence. The females cut crescent-shaped notches or punctures into the bark and deposit one or two creamy-white eggs in each. Oviposition tends to be concentrated on exposed parts of the trunk or in the lower crown. The eggs hatch in about 3 weeks, and the young larvae feed on the inner bark. The grublike larvae are without legs and have creamy-white bodies, brown heads, and brown thoracic shields (B). They are about 40 mm long when fully grown. First-year feeding ceases in October, and the larvae hibernate near the end of the burrows. Second-year feeding begins in late April or early May; the larvae bore through the sapwood into the heartwood, ejecting sawdust as they do so (D). The second winter is spent in a cell formed from tightly packed frass at the upper end of the burrow. Third-year feeding also begins in late April or early May. The larvae cease feeding in August and construct a hibernation cell at the end of the burrow in the heartwood. The insects spend the third winter as prepupae. Pupation starts by mid-May or early June of the 4th year, and adults develop soon after.

Damage

Trees infested with poplar borers often exude copious flows of varnishlike sap (C), which gives a characteristic stain to the bark surface (D, E). The same trees are often attacked repeatedly. Trees are not usually killed by poplar borer attack, even when riddled with tunnels, but the weakened stems are liable to break during windstorms, and the wood is almost useless for lumber or other purposes. Woodpeckers cause appreciable damage to the wood while searching for the larvae (F), and the openings maintained by the larvae for ejection of borings provide infection courts for various rot fungi.

Bibliography: 7, 45, 112, 139, 145, 175, 203, 221, 440

Figure 114. The poplar borer, *Saperda calcarata* Say. A. Adult *S. calcarata*. **B.** *S. calcarata* larva. **C.** Sap flow caused by *S. calcarata* larva. **D.** Sawdust ejected by *S. calcarata* larva. **E.** Fresh *S. calcarata* damage. **F.** Old *S. calcarata* and woodpecker damage.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CLEARWING MOTHS ON HARDWOODS (Figure 115)

Distribution, Hosts, and Importance

Moths in the genera *Paranthrene*, *Podosesia*, *Sesia*, and *Synanthedon* have wings that are largely devoid of scales, and they are therefore referred to as clearwing moths. The larvae of these moths bore into the stems of various hardwoods.

Paranthrene tabaniformis (Rottemburg) attacks willows and cultivated poplars but is of no economic importance. The ash borer, ***Podosesia syringae*** (Harris), attacks green ash and common lilac. It is a major pest of ash in the drier parts of the prairie provinces. The American hornet moth, ***Sesia tibialis*** (Harris), attacks poplar and willow. It is a serious pest in hybrid poplar stooling beds. The most common hardwood-infesting *Synanthedon* species in this region is the lesser peachtree borer, ***S. pictipes*** (Grote & Robinson), which breeds in black knot on choke cherry. Other species are the willow stem borer, ***S. albicornis*** (Hy. Edwards), and ***S. viburni*** Engelhardt, which breed in willow and viburnum, respectively. None are of economic importance in this region.

Life Cycle and Appearance

The life cycles of *Paranthrene tabaniformis*, *Podosesia syringae*, and *Sesia tibialis* are very similar. All three species bore into the stems or roots of their hosts, require 2 years to complete development in the prairie provinces, and overwinter twice in the larval stage. Pupation occurs in the spring of the 3rd year, and the adults emerge soon afterwards.

Paranthrene tabaniformis adults have a wingspan of about 25 mm and are black with transparent purplish wings. The males have three broad, yellow bands on the abdomen, and the females have four. Larvae are about 25 mm long at maturity and often feed in the galls caused by *Saperda concolor* LeConte and *S. populnea moesta* LeConte (Fig. 109).

Podosesia syringae adults emerge in June and early July and have a wingspan of about 30 mm. They have dark brown, transparent wings and dark brown or black bodies with yellow bands on the abdomen (A). The females lay their eggs in bark crevices or in tree wounds. The young larvae feed within the bark during the first summer, although some may have reached the wood by fall. The larvae (B) bore into the wood during the 2nd year, and their tunnels often extend for several centimetres. In the spring of the 3rd year, the larvae bore towards the surface, leaving only a thin layer of bark. Fully grown larvae are about 26 mm long. They have creamy-white bodies and brown heads and thoracic shields. The pupae push their way to the surface just prior to adult emergence.

Sesia tibialis moths have a wingspan of 30–40 mm and emerge in June and July. Their bodies are brownish black and have prominent yellow markings. Their wings are transparent and have reddish brown veins and edges (G). The larvae burrow in the cambial area of the roots and lower stem and occasionally bore into solid wood. Fully grown larvae are about 40 mm long and have white bodies, dark reddish brown heads, and light brown thoracic shields (H). Larvae in the basal stem tunnel through the bark in the fall of the second year, leaving only a thin protective covering. Mature larvae in the roots often enter the soil and construct silk-lined pupal chambers from the chips excavated during their tunneling. The pupae wriggle to the surface just before the adults emerge.

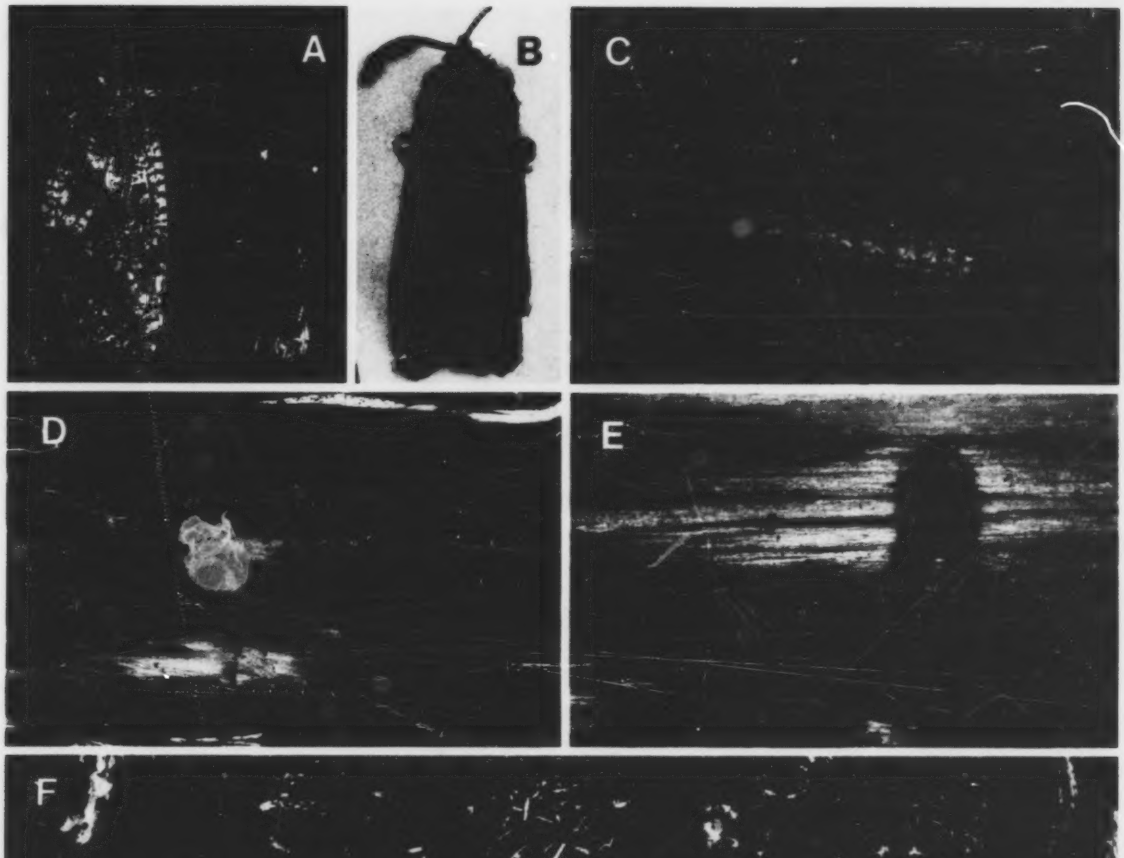
Synanthedon pictipes probably has one generation per year in the prairie provinces and overwinters in the larval stage. Adults have a wingspan of 17–26 mm and emerge in late spring or early summer. They have transparent wings that have bluish black edges and veins. The body is also bluish black, and there are two narrow, yellow bands on the abdomen. The larvae feed in black knot on choke cherry. Little is known about the biology of *S. albicornis* or *S. viburni*. Adult ***S. albicornis*** have a wingspan of 17–22 mm and are black with some yellow marks on the wings. Adult ***S. viburni*** (D) are bluish black and have white-tipped antennae and a wingspan of about 30 mm. The larvae (E) have brown heads and white bodies. They tunnel into the base of large viburnum clumps.

Damage

Tunneling by ***P. syringae*** weakens or kills young trees (C), especially in areas with low precipitation. ***Sesia tibialis*** weakens hybrid poplars in stooling beds (F), greatly reducing the yield of cuttings. The other clearwing moths cause no appreciable damage, although ***Synanthedon pictipes*** could become a problem in ornamental plantings of Schubert choke cherry if black knot is present.

Bibliography: 41, 52, 111, 130, 168, 355, 394, 443, 476, 539

Figure 115. Clearwing moths on hardwoods. A. Adult ash borer, *Podosesia syringae* (Harris). **B.** *P. syringae* larva. **C.** Green ash infested with *P. syringae*. **D.** Adult *Synanthedon viburni* Engelhardt. **E.** *S. viburni* larva. **F.** Hybrid poplar stool weakened by American hornet moth, *Sesia tibialis* (Harris), larvae. **G.** Adult *S. tibialis*. **H.** *S. tibialis* larva in root of hybrid poplar.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CARPENTERWORMS (Figure 116)

Distribution, Hosts, and Importance

The larvae of *Prionoxystus* and *Acossus* tunnel extensively in the wood of their hosts. Repeated attacks may literally riddle the wood with tunnels. The carpenterworm, ***P. robiniae*** (Peck), has a widespread distribution in North America and attacks a variety of hardwoods. Poplar and green ash are its principal hosts in the prairie provinces, where it is primarily a pest in shelterbelts and open-growing ornamentals. Two species of *Acossus* attack poplar in the prairie provinces. The distribution of the poplar carpenterworm, ***A. centerensis*** (Lintner), extends westward to Saskatchewan, whereas that of the aspen carpenterworm, ***A. populi*** (Walker), is transcontinental. Neither species is of economic importance.

Life Cycle and Appearance

Prionoxystus robiniae requires 3 or possibly 4 years to complete its life cycle in the prairie provinces. Adults emerge in June. They are mottled gray moths (A) and have a marked sexual dimorphism. The females have a wingspan of about 75 mm and have smoky gray hind wings. The males are much smaller, with a wingspan of about 50 mm, and the hind wings are yellowish orange with black margins. After mating, the female deposits up to 800 eggs in bark crevices or wounds on trunks and branches. The larvae burrow into the cambial area, where they excavate extensive tunnels that are kept clear of frass and are enlarged as the larvae grow. The tunnels that they construct in the heartwood (D) are believed to be primarily for protection. Fully grown larvae are 50–75 mm long. Most are greenish white and have brown heads and thoracic shields (C), but sometimes mixed populations of greenish larvae and brown-spotted pinkish larvae with reddish brown heads and thoracic shields are encountered in the same tree. Pupation occurs in May of the final year of development. The pupae work their way to the surface just prior to adult emergence (F).

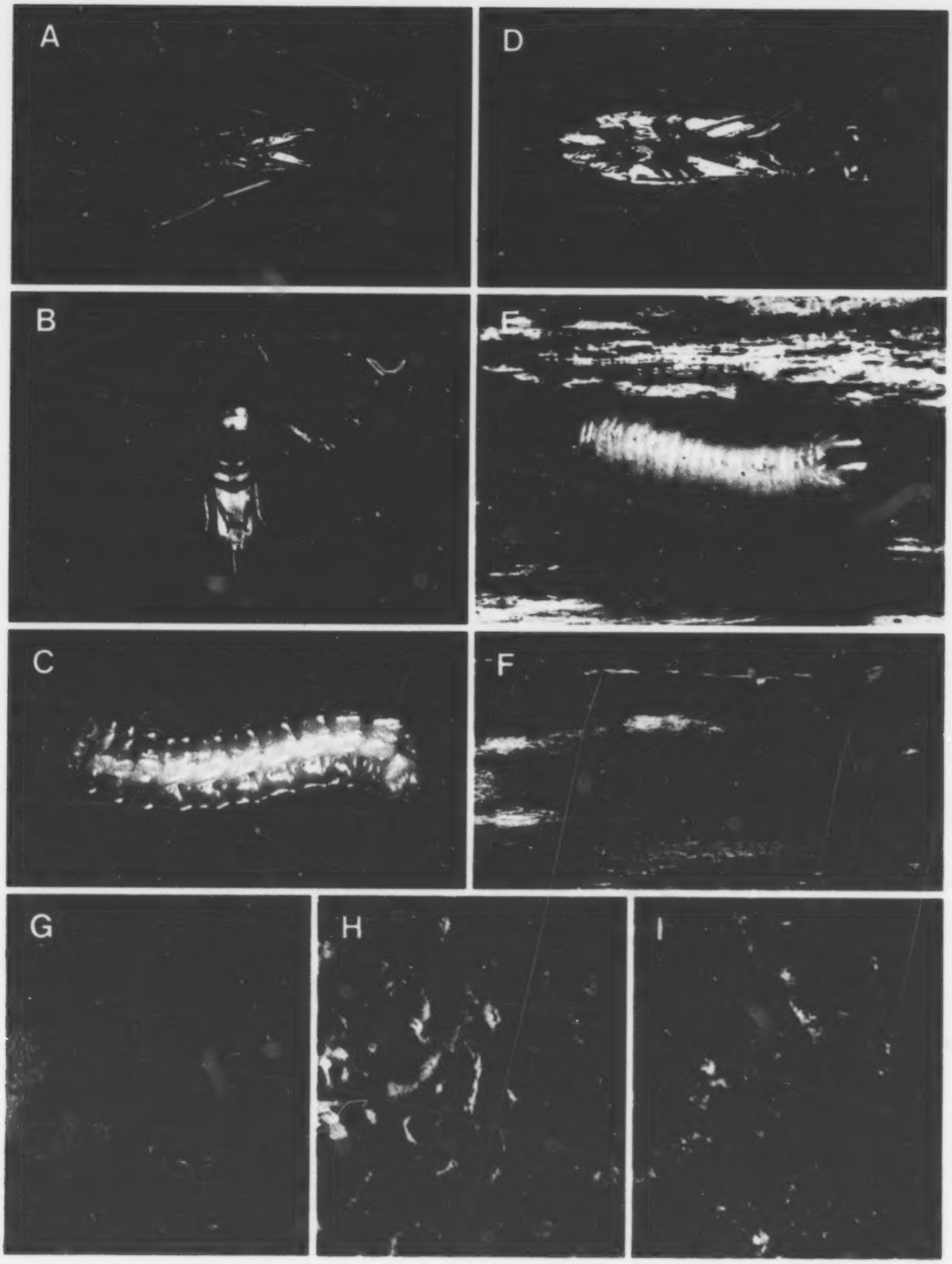
Little is known about the life cycles of either *Acossus* species, but they are probably similar to that of the carpenterworm. ***Acossus centerensis*** adults have a wingspan of 40–50 mm and emerge in late June or early July. Male (B) and female moths are similar in appearance and have a superficial resemblance to carpenterworm adults. The thorax is gray and has a transverse row of whitish setae that is especially noticeable in living specimens. The front wings are gray with broken, irregular gray bars, and the hind wings are uniformly gray. The larvae are creamy-white and have brown spots at the setal bases and dark brown heads and thoracic shields (E). They are 40–50 mm long when fully grown.

Damage

None of these carpenterworms are directly responsible for killing their hosts, although severely infested trees sometimes break off during windstorms. Repeated attacks may weaken the trees, however, and may make them more vulnerable to long periods of drought, especially in shelterbelt plantings. The extensive tunneling (D) renders affected trees unsuitable for lumber or other uses.

Bibliography: 131, 139, 203, 246, 394, 420, 443, 476, 538, 540

Figure 116. Carpenterworms. A. Adult carpenterworms, *Prionoxystus robiniae* (Peck). Female is on left; male is on right. **B.** Adult male poplar carpenterworm, *Acossus centerensis* (Lintner). **C.** Mature *P. robiniae* larva. **D.** *P. robiniae* tunnels in balsam poplar. **E.** Mature *A. centerensis* larva. **F.** *P. robiniae* pupal cases protruding from trunk of balsam poplar (at arrows).


A
D
B
E
C
F
G
H
I

WOODWASPS IN HARDWOODS (Figure 117)

Distribution, Hosts, and Importance

The pigeon tremex, ***Tremex columba*** (Linnaeus), is a common horntail or woodwasp that attacks a variety of dead and dying hardwoods including birch, elm, and maple. In the prairie provinces it is most commonly found in decadent white elm and Manitoba maple. ***Xiphydria mellipes*** Harris is a member of a closely related family of woodwasps that attacks birch and alder throughout the region. Attacks are concentrated in stems and branches that are 4–12 cm in diameter. ***Xiphydria tibialis*** Say breeds in elm and birch and occurs as far west as central Saskatchewan. ***Xiphydria maculata*** Say, on maple, and ***X. abdomalis*** Say, on basswood, may also occur in the region.

None of these insects are of economic importance.

Life Cycle and Appearance

Tremex columba probably has a 2-year life cycle in the prairie provinces and overwinters in the larval stage. Adults (A, B) emerge in August and September. Females are 37–50 mm long and have a wingspan of 40–50 mm. The head and thorax are reddish with some black, and the abdomen is black ventrally and ochre yellow with five black bands dorsally (B). The wings are smoky brown, the antennae are reddish, the legs are pale, and there is a caudal hornlike projection. The males are smaller, ranging in length from 18 to 37 mm, and are reddish black in color. The larvae (C) have yellowish heads and creamy-white bodies and reach a length of about 40 mm when mature. They are legless, and the rear of the abdomen is armed with a chitinous spine. Frass is packed tightly in the galleries (G), which may completely riddle some infested trees (H). Adults chew circular emergence holes (I) about 8 mm in diameter. Decadent Manitoba maple trees are reinfested as long as the wood is moist at the base of the tree.

The life cycle of ***X. mellipes*** is not well known. Two years are probably required to complete development. The simultaneous occurrence in early spring of pupae and larvae in different parts of the same trunk suggests that attacks occur from the top of the tree downwards. Adult females (D) resemble horntails but have shorter ovipositors and longer necks and lack a hornlike projection at the end of the abdomen. They are only 12–20 mm long. The head is black with pale markings, the thorax and abdomen are black, and the legs are reddish brown. The wings are smoky. The larvae (E) are whitish, and the thorax and rear of the abdomen are larger in diameter than the rest of the body. They are legless, and the rear of the abdomen bears a chitinous spine. Fully grown larvae are about 20 mm long. Frass is packed tightly behind the larvae (F), and pupal cells are formed near the surface of the wood. The larvae carry a fungus that stains the wood (E, F), and this fungus apparently is their main food source.

Damage

These woodwasps do not cause any damage, as they breed only in dead or dying trees. Adults may emerge from infested wood that is used for firewood, but they are harmless and will not sting people.

Bibliography: 139, 203, 417, 476, 530, 559

Figure 117. Woodwasps in hardwoods. A. Adult female pigeon tremex, *Tremex columba* (Linnaeus). **B.** *T. columba* adult female with wings spread to show abdomen. **C.** *T. columba* larva. **D.** Adult female *Xiphydria mellipes* Harris. **E.** *X. mellipes* larva in tunnel with blue-stain fungi. **F.** *X. mellipes* larval gallery and pupal cell with blue-stain fungi. **G.** Frass-filled *T. columba* larval galleries. **H.** *T. columba* larval galleries with frass removed. **I.** *T. columba* adult emergence holes.

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AUTHORS' NOTE

In addition to the above references that are cited in the text, the following pest leaflets published by the Northern Forestry Centre offer brief summaries of insect damage, control, and life cycle.

Aphids galore
Birch leaf miners
Cooley spruce gall aphid
Fall cankerworm
Forest tent caterpillar
Large aspen tortrix
Lilac leaf miner
Pear slug
Pine needle scale
Poplar bud gall mite
Sprayers and spraying
Spruce budworm
Spruce needle miner
Spruce spider mite
To spray or not to spray
Ugly-nest caterpillar
What's wrong with my tree
White pine weevil
A willow shoot-boring sawfly
Yellow-headed spruce sawfly

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  - *Monochamus notatus*, 87
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***Abies lasiocarpa* (Hooker) Nuttall** (alpine fir)

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Foliage, on
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    - *Phyllophaga drakii*, 115
    - *Phyllophaga rugosa*, 115
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  - Caterpillars
    - *Lithophane innominata*, 137
  - Loopers
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    - *Phyllophaga drakii*, 115
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  - Borers, flatheaded
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  - Cryptorhynchus lapathi, 221
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  - Cryptorhynchus lapathi, 221

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Alnus rugosa (Du Roi) Sprengel (speckled alder)

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***Alnus sinuata* (Regel) Rydberg** (sitka alder)
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***Alnus tenuifolia* Nuttall** (mountain alder)
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    - *Pseudothyatira cymatophoroides*, 145
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    - *Archips negundana*, 165
    - *Epinotia solandriana*, 167
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    - *Rheumaptera hastata*, 177
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    - *Plemyria georgii*, 183
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    - *Rheumaptera hastata*, 177
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Amelanchier (serviceberry, saskatoon)
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    - *Cecidomyia*, 155

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        - *Probole amicaria*, 179
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        - *Dimorphopteryx abnormis*, 195
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    - Weevils
        - *Pseudanthonomus crataegi*, 105
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    - Aphids, woolly
        - *Eriosoma americanum*, 159
  - Roots or basal stem, in wood
    - Borers, roundheaded
        - *Saperda candida*, 225
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    - Borers, roundheaded
        - *Saperda candida*, 225
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- Aspen (see *Populus*)
- Basswood (see *Tilia*)

- ***Betula*** (birch)
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    - Miners; moths
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        - *Fenusa pusilla*, 201
        - *Heterarthrus nemoratus*, 201
        - *Profenusa thomsoni*, 201
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    - Beetles, leaf
        - *Calligrapha ignota*, 111
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        - *Phyllophaga anxia*, 115
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        - *Priophorus pallipes*, 193
        - *Pristiphora siskiyouensis*, 197
        - *Trichiosoma triangulum*, 191
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        - *Bucculatrix canadensisella*, 199
    - Tube makers
        - *Acrobasis betulella*, 169
  - Trunk or large branches, in wood
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        - *Tremex columba*, 239
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Lepidosaphes ulmi, 215
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***Betula alba* Linnaeus** (European white birch)
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***Betula glandulosa* Michaux** (dwarf birch)
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Pero morrisonaria, 181
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Rheumaptera hastata, 177
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***Betula occidentalis* Hooker** (water birch)
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***Betula papyrifera* Marshall** (white birch)
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Pterourus glaucus canadensis, 121
Raphia frater, 145
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    - *Epinotia solandriana*, 167
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    - *Nites betulella*, 171
    - *Pandemis limitata*, 167
    - *Pseudosciaphila duplex*, 167
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    - *Schizura concinna*, 131
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    - *Protitame virginalis*, 177
    - *Protoboarmia porcelaria indicataria*, 23, 27
    - *Rheumaptera hastata*, 177
    - *Semiothisa ulsterata*, 181
    - *Sicya macularia*, 181
  - Sawflies
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    - *Arge cyra*, 191
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    - *Cimbex americana*, 191
    - *Croesus latitarsus*, 197
    - *Dimorphopteryx melanognathus*, 195
    - *Nematinus unicolor*, 193
    - *Nematus pinguidorsum*, 189
    - *Priophorus pallipes*, 193
    - *Pristiphora siskiyouensis*, 197
    - *Trichiosoma triangulum*, 191
  - Skeletonizers
    - *Bucculatrix canadensisella*, 199
  - Tube makers
    - *Acrobasis betulella*, 169
  - Walkingsticks
    - *Diapheromera femorata*, 187
  - Webworms and their allies
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    - *Hyphantria cunea*, 151
    - *Meroptera pravella*, 169
    - *Tetralopha aplastella*, 169
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  - Beetles, darkling
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  - Borers, flatheaded
    - *Dicerca hesperoborealis*, 231
  - Borers, roundheaded
    - *Trachysida mutabilis*, 231
    - *Trigonarthris proxima*, 231
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    - *Tremex columba*, 239
  - Weevils
    - *Cryptorhynchus lapathi*, 221
  - Woodwasps
    - *Xiphydria mellipes*, 239
    - *Xiphydria tibialis*, 239
- Trunk or large branches, under bark
  - Beetles, darkling
    - *Upis ceramboides*, 231
  - Borers, flatheaded
    - *Agrilus anxius*, 229
  - Weevils
    - *Cryptorhynchus lapathi*, 221

Betula papyrifera* Marshall var. *commutata (Regel) Fernald
(western paper birch)
- Foliage, on
  - Caterpillars

- ***Betula papyrifera* continued**
    - *Acronicta grisea*, 125
    - *Drepana bilineata*, 143
    - *Nadata gibbosa*, 135
    - *Phyllodesma americana*, 129
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    - *Rheumaptera hastata*, 177
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    - *Besma quercivoraria*, 179
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    - *Hyphantria cunea*, 151
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    - Borers, flatheaded
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- Birch (see *Betula*)
- Buffaloberry (see *Shepherdia*)

- ***Caragana*** (caragana)
  - Buds or shoots, in
    - Budworms and their allies
      - *Archips argyrospila*, 165
  - Foliage, on
    - Aphids
      - *Acyrthosiphon caraganae*, 107
    - Beetles, blister
      - *Epicauta fabrici*, 115
      - *Lytta nuttalli*, 115
      - *Lytta viridana*, 115
    - Bugs, plant
      - *Lopidea dakota*, 119
      - *Lygus lineolaris*, 119
    - Caterpillars
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      - *Alsophila pometaria*, 175
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      - *Biston betularia cognataria*, 181
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      - *Hyphantria cunea*, 151
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    - Aphids
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- ***Cornus*** (dogwood)
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      - *Phyllophaga drakii*, 115
      - *Phyllophaga nitida*, 115
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      - *Lithophane innominata*, 137
      - *Morrisonia evicta*, 137
      - *Sphinx chersis*, 141
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      - *Euchlaena marginaria*, 179
      - *Hesperumia sulphuraria*, 183
      - *Hypagyrtis unipunctata*, 185
      - *Lycia rachelae*, 181
      - *Melanolophia canadaria*, 185
      - *Phigalia titea*, 179
      - *Plemyria georgii*, 183
      - *Probole alienaria*, 179
      - *Probole amicaria*, 179
      - *Synaxis jubararia*, 183
    - Sawflies
      - *Macremphytus tarsatus*, 193
      - *Macremphytus testaceus*, 193
    - Webworms and their allies
      - *Hyphantria cunea*, 151
    - Weevils
      - *Otiorhynchus ovatus*, 95
  - Seedlings, on roots or stems
    - Weevils
      - *Otiorhynchus ovatus*, 95

- ***Cornus alternifolia* Carl von Linné** (alternate-leaved dogwood)
  - Buds or shoots, in
    - Budworms and their allies
      - *Choristoneura conflictana*, 163
  - Foliage, on
    - Caterpillars
      - *Acronicta dactylina*, 125
      - *Acronicta grisea*, 125
      - *Anisota virginiensis*, 133
      - *Heterocampa guttivitta*, 135
      - *Orthosia hibisci*, 137
      - *Schizura concinna*, 131
      - *Schizura unicornis*, 131
    - Leaf rollers
      - *Choristoneura conflictana*, 163
    - Leaf skeletonizers
      - *Schizura concinna*, 131
    - Loopers
      - *Hydria undulata*, 183
      - *Melanolophia canadaria*, 185
      - *Probole amicaria*, 179

- ***Cornus stolonifera* Michaux** (red osier)
  - Foliage, on
    - Caterpillars
      - *Acronicta grisea*, 125
      - *Antheraea polyphemus*, 123
      - *Eudeilinia herminiata*, 143
      - *Lithophane innominata*, 137
      - *Morrisonia evicta*, 137
      - *Orthosia hibisci*, 137
      - *Papestra cristifera*, 137
      - *Schizura unicornis*, 131
      - *Spilosoma dubia*, 129
    - Loopers
      - *Anavitrinelia pampinaria*, 179
      - *Biston betularia cognataria*, 181
      - *Euchlaena marginaria*, 179

- ***Cornus stolonifera*** **continued**
      - *Eutrapela clemataria*, 179
      - *Hypagyrtis unipunctata*, 179, 185
      - *Lycia rachelae*, 181
      - *Nematocampa limbata*, 21, 143
      - *Plemyria georgii*, 183
      - *Probole alienaria*, 179
      - *Probole amicaria*, 179
      - *Prochoerodes transversata*, 179
    - Sawflies
      - *Macremphytus tarsatus*, 193
      - *Macremphytus testaceus*, 193
    - Weevils
      - *Otiorhynchus ovatus*, 95
  - Seedlings, on roots or stems
    - Weevils
      - *Otiorhynchus ovatus*, 95

- ***Corylus*** (hazel)
  - Buds or shoots, in
    - Budworms and their allies
      - *Choristoneura conflictana*, 163
  - Foliage, on
    - Beetles, scarab
      - *Dichelonyx subvittata*, 115
    - Bugs, lace
      - *Corythucha pallipes*, 117
    - Caterpillars
      - *Acronicta grisea*, 125
      - *Actias luna*, 123
      - *Amphipyra pyramidoides*, 145
      - *Anisota virginiensis*, 133
      - *Bomolocha palparia*, 139
      - *Datana ministra*, 135
      - *Eupsilia tristigmata*, 145
      - *Halysidota tessellaris*, 127
      - *Lithophane innominata*, 137
      - *Lophocampa maculata*, 127
      - *Nadata gibbosa*, 135
      - *Orthosia hibisci*, 137
      - *Pterourus glaucus canadensis*, 121
      - *Schizura concinna*, 131
      - *Schizura leptinoides*, 131
      - *Schizura unicornis*, 131
      - *Spilosoma virginica*, 127
    - Caterpillars, tent
      - *Malacosoma americanum*, 149
      - *Malacosoma disstria*, 147, 229
    - Leaf rollers
      - *Agonopterix argillacea*, 169
      - *Choristoneura conflictana*, 163
      - *Choristoneura rosaceana*, 169
      - *Nites betulella*, 171
      - *Nites grotella*, 171
      - *Pseudosciaphila duplex*, 167
    - Leaf skeletonizers
      - *Datana ministra*, 135
      - *Schizura concinna*, 131
    - Leaftiers
      - *Nites betulella*, 171
      - *Nites grotella*, 171
      - *Rheumaptera hastata*, 177
    - Loopers
      - *Ennomos subsignaria*, 177
      - *Erannis tiliaria*, 177
      - *Hypagyrtis unipunctata*, 179, 185
      - *Itame exauspicata*, 181
      - *Itame loricaria julia*, 181
      - *Lomographa semiclarata*, 179
      - *Lycia rachelae*, 181
      - *Metanema inatomaria*, 177
      - *Nematocampa limbata*, 21, 143
      - *Phigalia titea*, 179
      - *Plagodis phlogosaria approximaria*, 179
      - *Probole amicaria*, 179
      - *Rheumaptera hastata*, 177
    - Tube makers
      - *Acrobasis betulella*, 169
    - Webworms and their allies
      - *Archips cerasivorana*, 151
      - *Hyphantria cunea*, 151
      - *Tetralopha aplastella*, 169
  - Twigs or small branches, on bark
    - Treehoppers
      - *Ceresa bisonia*, 161
      - *Ceresa diceros*, 161
- Cottonwood (see *Populus*)

- ***Crataegus*** (hawthorn)
  - Foliage, on
    - Bugs, lace
      - *Corythucha cydoniae*, 117
    - Caterpillars
      - *Antheraea polyphemus*, 123
      - *Basilarchia arthemis*, 121
      - *Dasychira vagans*, 127
      - *Datana ministra*, 135
      - *Halysidota tessellaris*, 127
      - *Heterocampa guttivitta*, 135
      - *Schizura concinna*, 131
      - *Schizura unicornis*, 131
    - Caterpillars, tent
      - *Malacosoma americanum*, 149
      - *Malacosoma californicum pluviale*, 149
    - Leaf rollers
      - *Epinotia solandriana*, 167
    - Leaf skeletonizers
      - *Caliroa cerasi*, 199
      - *Datana ministra*, 135
      - *Schizura concinna*, 131
    - Loopers
      - *Anavitrinelia pampinaria*, 179
      - *Erannis tiliaria*, 177
      - *Eufidonia discospilata*, 27
      - *Itame coortaria enigmata*, 181
      - *Itame exauspicata*, 181
      - *Lomographa semiclarata*, 179
      - *Metarranthis duaria*, 183
      - *Nemoria mimosaria*, 143
      - *Phigalia titea*, 179
      - *Probole alienaria*, 179
    - Sawflies
      - *Arge clavicornis*, 191
      - *Caliroa cerasi*, 199
      - *Priophorus pallipes*, 193
    - Skeletonizers
      - *Caliroa cerasi*, 199
    - Webworms and their allies
      - *Archips cerasivorana*, 151
      - *Hyphantria cunea*, 151
    - Weevils
      - *Otiorhynchus sulcatus*, 95

- ***Crataegus* continued**
  - Roots, on
    - Aphids, woolly
      - *Eriosoma lanigerum*, 159
  - Roots or basal stem, in wood
    - Borers, roundheaded
      - *Saperda candida*, 225
  - Roots or basal stem, under bark
    - Borers, roundheaded
      - *Saperda candida*, 225
  - Seedlings, on roots or stems
    - Weevils
      - *Otiorhynchus sulcatus*, 95
  - Trunk or large branches, in wood
    - Ants, carpenter
      - *Camponotus herculeanus*, 93
    - Borers, roundheaded
      - *Saperda candida*, 225
  - Trunk or large branches, on bark
    - Aphids, woolly
      - *Eriosoma lanigerum*, 159
  - Twigs or small branches, on bark
    - Scales
      - *Chionaspis furfura*, 215
    - Treehoppers
      - *Telamona scalaris*, 161
- Dogwood (see *Cornus*)
- Douglas-fir (see *Pseudotsuga*)

- ***Elaeagnus commutata* Bernhardi** (silverberry)
  - Foliage, on
    - Caterpillars
      - *Hyalophora gloveri nokomis*, 123
- Elder (see *Sambucus*)
- Elm (see *Ulmus*)
- Fir (see *Abies*)

- ***Fraxinus*** (ash)
  - Flowers, staminate
    - Gall formers; mites
      - *Aceria fraxiniflora*, 213
  - Foliage, on
    - Beetles, blister
      - *Lytta sphaericollis*, 115
    - Bugs, plant
      - *Leptocoris trivittatus*, 119
      - *Tropidosteptes amoenus*, 119
    - Bugs, stink
      - *Banasa dimidiata*, 65, 119
    - Caterpillars
      - *Sphinx chersis*, 141
      - *Tolype velleda*, 129
    - Gall formers; midges
      - *Contarinia canadensis*, 159
    - Leaf rollers
      - *Archips purpurana*, 169
    - Loopers
      - *Ennomos magnaria*, 177
      - *Ennomos subsignaria*, 177
      - *Erannis tiliaria*, 177
      - *Euchlaena marginaria*, 179
      - *Melanolophia canadaria*, 185
      - *Nematocampa limbata*, 21, 143
      - *Sicya macularia*, 181
    - Sawflies
      - *Eupareophora parca*, 195
      - *Tethida cordigera*, 197
      - *Tomostethus multicinctus*, 197
      - *Trichiosoma triangulum*, 191
    - Walkingsticks
      - *Diapheromera femorata*, 187
  - Fruits or seeds
    - Bugs, plant
      - *Leptocoris trivittatus*, 119
    - Weevils
      - *Thysanocnemis bischoffi*, 103
      - *Thysanocnemis helvola*, 103
  - Trunk or large branches, in wood
    - Moths, clearwing
      - *Podosesia syringae*, 235
  - Trunk or large branches, on bark
    - Scales
      - *Chionaspis furfura*, 215
      - *Lepidosaphes ulmi*, 215
      - *Quadraspidiotus perniciosus*, 215
  - Trunk or large branches, under bark
    - Beetles, bark
      - *Hylesinus aculeatus*, 231
      - *Hylesinus californicus*, 231
      - *Hylesinus criddlei*, 231
  - Twigs or small branches, on bark
    - Scales
      - *Chionaspis furfura*, 215
      - *Lepidosaphes ulmi*, 215
      - *Parthenolecanium corni*, 215
      - *Quadraspidiotus perniciosus*, 215
    - Treehoppers
      - *Ceresa bisonia*, 161
  - Twigs or small branches, under bark
    - Beetles, bark
      - *Hylesinus californicus*, 231

- ***Fraxinus nigra* Marshall** (black ash)
  - Foliage, in
    - Miners; moths
      - *Gracillaria syringella*, 205
  - Foliage, on
    - Caterpillars
      - *Haploa confusa*, 129
      - *Lophocampa maculata*, 127
    - Caterpillars, tent
      - *Malacosoma disstria*, 147, 229
    - Leaf rollers
      - *Gracillaria syringella*, 205
      - *Pseudosciaphila duplex*, 167
    - Webworms and their allies
      - *Hyphantria cunea*, 151

- ***Fraxinus pennsylvanica* Marshall var. *subintegerrima* (Vahl) Fernald** (green ash)
  - Buds or shoots, in
    - Miners; moths
      - *Malacosoma disstria*, 147, 229
  - Flowers, staminate
    - Gall formers; mites
      - *Aceria fraxiniflora*, 213
  - Foliage, on
    - Beetles, blister
      - *Lytta sphaericollis*, 115
    - Bugs, plant
      - *Tropidosteptes amoenus*, 119

Fraxinus pennsylvanica continued
- Caterpillars
  - *Acronicta americana*, 125
  - *Amphipyra pyramidoides*, 145
  - *Halysidota tessellaris*, 127
  - *Heterocampa guttivitta*, 135
  - *Hyalophora cecropia*, 123
  - *Lophocampa maculata*, 127
  - *Orthosia hibisci*, 137
  - *Pterourus glaucus canadensis*, 121
  - *Sphinx chersis*, 141
  - *Tolype velleda*, 129
- Caterpillars, tent
  - *Malacosoma disstria*, 147, 229
- Gall formers; midges
  - *Contarinia canadensis*, 159
- Gall formers; mites
  - *Eriophyes*, 153
- Leaf rollers
  - *Pseudosciaphila duplex*, 167
- Loopers
  - *Alsophila pometaria*, 175
  - *Anacamptodes ephyraria*, 183
  - *Ennomos magnaria*, 177
  - *Ennomos subsignaria*, 177
  - *Eutrapela clemataria*, 179
  - *Hypagyrtis unipunctata*, 179, 185
  - *Melanolophia canadaria*, 185
  - *Metanema determinata*, 177
  - *Nemoria mimosaria*, 143
  - *Paleacrita vernata*, 175
  - *Phigalia titea*, 179
  - *Sicya macularia*, 181
- Sawflies
  - *Eupareophora parca*, 195
  - *Tethida cordigera*, 197
- Webworms and their allies
  - *Hyphantria cunea*, 151
- Roots or basal stem, in wood
  - Moths, clearwing
    - *Podosesia syringae*, 235
- Trunk or large branches, in wood
  - Carpenterworms
    - *Prionoxystus robiniae*, 237
  - Moths, clearwing
    - *Podosesia syringae*, 235
- Twigs or small branches, on bark
  - Mites
    - *Aceria fraxiniflora*, 213

Hawthorn (see *Crataegus*)
Hazel (see *Corylus*)
Honeysuckle (see *Lonicera*)
Hop hornbeam (see *Ostrya*)
Ironwood (see *Ostrya*)
Juniper (see *Juniperus*)

Juniperus (juniper)
- Foliage, in
  - Miners; moths
    - *Aethes rutilana*, 49
- Foliage, on
  - Bugs, stink
    - *Banasa dimidiata*, 65
    - *Chlorochroa persimilis*, 65
  - Caterpillars
    - *Palthis angulalis*, 17
  - Loopers
    - *Eupithecia pusillata interruptofasciata*, 25
    - *Prochoerodes transversata*, 179
    - *Thera contractata*, 25
    - *Thera otisi*, 25
  - Mites
    - *Oligonychus ununguis*, 31
  - Scales
    - *Parthenolecanium fletcheri*, 71
  - Webworms and their allies
    - *Aethes rutilana*, 49
  - Weevils
    - *Otiorhynchus ovatus*, 95
- Seedlings, on roots or stems
  - Weevils
    - *Otiorhynchus ovatus*, 95
    - *Otiorhynchus sulcatus*, 95
- Trunk or large branches, in wood
  - Borers, roundheaded
    - *Semanotus ligneus ligneus*, 89
- Trunk or large branches, under bark
  - Borers, roundheaded
    - *Semanotus ligneus ligneus*, 89
- Twigs or small branches, on bark
  - Scales
    - *Parthenolecanium fletcheri*, 71
  - Weevils
    - *Otiorhynchus ovatus*, 95
    - *Otiorhynchus sulcatus*, 95

Juniperus communis Linnaeus (common juniper)
- Foliage, in
  - Miners; moths
    - *Aethes rutilana*, 49
- Foliage, on
  - Budworms and their allies
    - *Epinotia radicana*, 29
  - Loopers
    - *Eupithecia pusillata interruptofasciata*, 25
    - *Thera contractata*, 25
    - *Thera otisi*, 25
  - Sawflies
    - *Monoctenus melliceps*, 39
  - Webworms and their allies
    - *Aethes rutilana*, 49

Juniperus scopulorum Sargent (Rocky Mountain juniper)
- Foliage, in
  - Miners; moths
    - *Aethes rutilana*, 49
- Foliage, on
  - Caterpillars
    - *Eilema bicolor*, 19
    - *Palthis angulalis*, 17
  - Loopers
    - *Protoboarmia porcelaria indicataria*, 23, 27
    - *Semiothisa setonana*, 23
    - *Semiothisa signaria dispuncta*, 23
    - *Thera contractata*, 25
    - *Thera otisi*, 25
  - Webworms and their allies
    - *Aethes rutilana*, 49

Larch (see *Larix*)

Larix (larch)
- Foliage, in
  - Miners; moths
    - *Coleophora laricella*, 49
    - *Coleotechnites laricis*, 61
- Foliage, on
  - Aphids, woolly
    - *Adelges lariciatus*, 51
    - *Adelges strobilobius*, 51
  - Casebearers
    - *Coleophora laricella*, 49
  - Caterpillars
    - *Melanchra pulverulenta*, 151
  - Loopers
    - *Anacamptodes vellivolata*, 25, 27
    - *Biston betularia cognataria*, 181
    - *Campaea perlata*, 177
    - *Caripeta angustiorata*, 27
    - *Caripeta divisata*, 27
    - *Cladara limitaria*, 27
    - *Dysstroma walkerata*, 27
    - *Ectropis crepuscularia*, 27, 177
    - *Eupithecia fletcherata*, 25
    - *Eupithecia luteata*, 25
    - *Eupithecia transcanadata*, 25
    - *Hydriomena divisaria*, 25
    - *Nematocampa limbata*, 21, 143
    - *Pero honestaria*, 181
    - *Semiothisa sexmaculata*, 23
    - *Semiothisa signaria dispuncta*, 23
  - Sawflies
    - *Anoplonyx canadensis*, 39
    - *Anoplonyx luteipes*, 39
    - *Pristiphora erichsonii*, 37
  - Tube makers
    - *Coleotechnites laricis*, 61
  - Weevils
    - *Hylobius pales*, 99
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
- Roots, on
  - Weevils
    - *Hylobius pales*, 99
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
- Roots or basal stem, under bark
  - Weevils
    - *Hylobius pales*, 99
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
- Trunk or large branches, in wood
  - Borers, roundheaded
    - *Semanotus litigiosus*, 89
  - Horntails
    - *Sirex cyaneus*, 91
    - *Urocerus albicornis*, 91
    - *Urocerus gigas flavicornis*, 91
    - *Xeris spectrum spectrum*, 91
- Trunk or large branches, under bark
  - Beetles, bark
    - *Dendroctonus valens*, 79
  - Borers, flatheaded
    - *Melanophila drummondi*, 89
  - Borers, roundheaded
    - *Semanotus litigiosus*, 89
- Twigs or small branches, on bark
  - Aphids, woolly
    - *Adelges lariciatus*, 51
    - *Adelges strobilobius*, 51

***Larix laricina* (Du Roi) K. Koch** (tamarack)
- Buds or shoots, in
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Archips alberta*, 9
    - *Choristoneura fumiferana*, 9, 15, 29, 47
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria reniculelloides*, 9, 29
    - *Zeiraphera improbana*, 29
  - Moths, tip
    - *Argyresthia* nr. *laricella*, 57
- Cones or seeds
  - Chalcids
    - *Megastigmus*, 7
  - Maggots
    - *Delia laricicola*, 7
  - Moths
    - *Archips alberta*, 9
    - *Dioryctria reniculelloides*, 9, 29
    - *Hercu*l*ia thymetusalis*, 9
- Foliage, in
  - Miners; moths
    - *Coleophora laricella*, 49
    - *Coleotechnites laricis*, 61
- Foliage, on
  - Beetles, longhorned
    - *Monochamus scutellatus*, 87
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Choristoneura fumiferana*, 9, 15, 29, 47
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria reniculelloides*, 9, 29
    - *Epinotia radicana*, 29
    - *Zeiraphera improbana*, 29
  - Casebearers
    - *Coleophora laricella*, 49
  - Caterpillars
    - *Acronicta lanceolaria*, 19
    - *Alypia langtoni*, 21
    - *Anomogyna elimata*, 17
    - *Anomogyna perquiritata*, 17
    - *Dasychira plagiata*, 19
    - *Dasychira vagans*, 127
    - *Eilema bicolor*, 19
    - *Elaphria versicolor*, 17
    - *Feralia jocosa*, 17
    - *Hyalophora columbia*, 21
    - *Ipimorpha pleonectusa*, 137
    - *Lapara bombycoides*, 21
    - *Lithophane thaxteri*, 17
    - *Lymantria dispar*, 127
    - *Melanchra pulverulenta*, 17
    - *Orgyia antiqua*, 19, 127
    - *Orgyia leucostigma*, 19, 127
    - *Orthosia hibisci*, 137
    - *Palthis angulalis*, 17
    - *Panthea acronyctoides*, 19
    - *Panthea pallescens*, 19
    - *Papestra cristifera*, 137

- ***Larix laricina* continued**
      - *Sphinx gordius*, 21
      - *Syngrapha alias interalia*, 17
      - *Syngrapha rectangula*, 17
      - *Syngrapha viridisigma*, 17
      - *Tolype laricis*, 19
      - *Xylotype acadia*, 145
    - Leaftiers
      - *Archips packardiana*, 29
      - *Argyrotaenia occultana*, 29
      - *Herculia thymetusalis*, 9
    - Loopers
      - *Anacamptodes vellivolata*, 25, 27
      - *Biston betularia cognataria*, 181
      - *Campaea perlata*, 177
      - *Caripeta angustiorata*, 27
      - *Caripeta divisata*, 27
      - *Cladara limitaria*, 27
      - *Cyclophora pendulinaria*, 183
      - *Dysstroma walkerata*, 27
      - *Ectropis crepuscularia*, 27, 177
      - *Eufidonia discospilata*, 127
      - *Eufidonia notataria*, 27
      - *Eupithecia filmata*, 25
      - *Eupithecia fletcherata*, 25
      - *Eupithecia gibsonata*, 25
      - *Eupithecia luteata*, 25
      - *Eupithecia maestosa*, 25
      - *Eupithecia palpata*, 25
      - *Eupithecia subfuscata*, 25
      - *Eupithecia transcanadata*, 25
      - *Hydriomena divisaria*, 25
      - *Hydriomena furcata*, 185
      - *Hypagyrtis piniata*, 27
      - *Itame exauspicata*, 181
      - *Lambdina fiscellaria*, 27, 177
      - *Lobophora nivigerata*, 183
      - *Melanolophia canadaria*, 185
      - *Melanolophia signataria*, 185
      - *Nematocampa limbata*, 21, 143
      - *Nemoria mimosaria*, 143
      - *Nepytia canosaria*, 23
      - *Pero morrisonaria*, 181
      - *Probole amicaria*, 179
      - *Prochoerodes transversata*, 179
      - *Protoboarmia porcelaria indicataria*, 23, 27
      - *Semiothisa oweni*, 23
      - *Semiothisa sexmaculata*, 23, 27
      - *Semiothisa signaria dispuncta*, 23
    - Sawflies
      - *Anoplonyx canadensis*, 39
      - *Anoplonyx luteipes*, 39
      - *Pristiphora erichsonii*, 17
    - Tube makers
      - *Coleotechnites laricis*, 61
    - Weevils
      - *Hylobius pinicola*, 99
  - Roots or basal stem, under bark
    - Weevils
      - *Hylobius pinicola*, 99
  - Trunk or large branches, in wood
    - Borers, roundheaded
      - *Monochamus scutellatus*, 87
    - Horntails
      - *Urocerus albicornis*, 91
  - Trunk or large branches, under bark
    - Beetles, bark
      - *Dendroctonus simplex*, 79
    - Borers, roundheaded
      - *Monochamus scutellatus*, 87
  - Twigs or small branches, in wood
    - Moths, tip
      - *Argyresthia* nr. *laricella*, 57
  - Twigs or small branches, on bark
    - Aphids
      - *Cinara*, 63
    - Aphids, woolly
      - *Adelges laricialus*, 51
      - *Adelges strobilobius*, 51
    - Beetles, longhorned
      - *Monochamus scutellatus*, 87
    - Spittlebugs
      - *Aphrophora gelida*, 65
    - Weevils
      - *Hylobius pinicola*, 99

- ***Larix lyallii* Parlatore** (alpine larch)
  - Cones or seeds
    - Maggots
      - *Delia laricicola*, 7
  - Foliage, on
    - Budworms and their allies
      - *Epinotia radicana*, 29
      - *Zeiraphera improbana*, 29
    - Caterpillars
      - *Panthea acronyctoides*, 19
    - Sawflies
      - *Pristiphora erichsonii*, 37

- ***Larix occidentalis* Nuttall** (western larch)
  - Buds or shoots, in
    - Budworms and their allies
      - *Acleris variana*, 15
      - *Choristoneura fumiferana*, 9, 15, 29, 47
      - *Dioryctria abietivorella*, 9, 85
      - *Epinotia radicana*, 29
      - *Zeiraphera improbana*, 29
    - Moths, tip
      - *Argyresthia* nr. *laricella*, 57
  - Cones or seeds
    - Maggots
      - *Delia laricicola*, 7
    - Moths
      - *Dioryctria abietivorella*, 9, 85
  - Foliage, in
    - Miners; moths
      - *Coleophora laricella*, 49
  - Foliage, on
    - Budworms and their allies
      - *Acleris variana*, 15
      - *Choristoneura fumiferana*, 9, 15, 29, 47
      - *Dioryctria abietivorella*, 9, 85
      - *Epinotia radicana*, 29
    - Casebearers
      - *Coleophora laricella*, 49
    - Caterpillars
      - *Dasychira grisefacta*, 19
      - *Eilema bicolor*, 19
      - *Lithophane innominata*, 137
      - *Melanchra pulverulenta*, 17

***Larix occidentalis* continued**
Orgyia antiqua, 19, 127
Palthis angulalis, 17
Papestra cristifera, 137
Leaftiers
Archips packardiana, 29
Loopers
Anavitrinelia pampinaria, 179
Caripeta divisata, 27
Cladara limitaria, 27
Ectropis crepuscularia, 27, 177
Eupithecia fletcherata, 25
Hesperumia sulphuraria, 183
Hypagyrtis piniata, 27
Lambdina fiscellaria, 27, 177
Nematocampa limbata, 21, 143
Nepytia freemani, 23
Protoboarmia porcelaria indicataria, 23, 27
Semiothisa sexmaculata, 23, 27
Semiothisa signaria dispuncta, 23
Sawflies
Pristiphora erichsonii, 37
Trunk or large branches, in wood
Horntails
Urocerus albicornis, 91
Urocerus gigas flavicornis, 91
Xeris spectrum spectrum, 91
Trunk or large branches, under bark
Beetles, bark
Dendroctonus pseudotsugae, 79
Borers, flatheaded
Melanophila drummondi, 89
Moths, pitch
Dioryctria abietivorella, 9, 85
Weevils
Pissodes schwarzi, 73
Twigs or small branches, under bark
Moths, twig
Dioryctria abietivorella, 9, 85

Lonicera (honeysuckle)
Foliage, on
Beetles, blister
Lytta sphaericollis, 115
Caterpillars
Arctia caja americana, 129
Gall formers; aphids
Hyadaphis tataricae, 107
Twigs or small branches, on bark
Aphids
Hyadaphis tataricae, 107
Maple (see *Acer*)
May Day tree (see *Prunus*)
Mountain-ash (see *Sorbus*)
Nannyberry (see *Viburnum*)
Oak (see *Quercus*)

***Ostrya virginiana* (Miller) K. Koch** (hop hornbeam, ironwood)
Foliage, on
Bugs, lace
Corythucha pallipes, 117
Caterpillars
Actias luna, 123
Amphipyra pyramidoides, 145
Antheraea polyphemus, 123
Bomolocha palparia, 139
Datana ministra, 135
Eupsilia tristigmata, 145
Halysidota tessellaris, 127
Heterocampa guttivitta, 135
Lochmaeus manteo, 133
Nymphalis antiopa, 121
Orgyia leucostigma, 19, 127
Orthosia hibisci, 137
Palthis angulalis, 17
Schizura leptinoides, 131
Schizura unicornis, 131
Caterpillars, tent
Malacosoma disstria, 147, 229
Leaf skeletonizers
Datana ministra, 135
Lochmaeus manteo, 133
Loopers
Ennomos magnaria, 177
Ennomos subsignaria, 177
Erannis tiliaria, 177
Hypagyrtis unipunctata, 179, 185
Lambdina fiscellaria, 27, 177
Nematocampa limbata, 21, 143
Nemoria mimosaria, 143
Phigalia titea, 179
Probole amicaria, 179
Prochoerodes transversata, 179
Webworms and their allies
Hyphantria cunea, 151

Picea (spruce)
Buds or shoots, in
Budworms and their allies
Choristoneura fumiferana, 9, 15, 29, 47
Dioryctria abietivorella, 9, 85
Dioryctria reniculelloides, 9, 29
Gall formers; adelgids
Adelges cooleyi, 11, 51
Adelges lariciatus, 51
Pineus pinifoliae, 51
Midges, bud
Rhabdophaga swainei, 53
Cones or seeds
Chalcids
Megastigmus, 7
Maggots
Dasineura canadensis, 7
Dasineura rachiphaga, 7
Mayetiola carpophaga, 7
Resseliella, 7
Moths
Archips alberta, 9
Choristoneura fumiferana, 9, 15, 29, 47
Cydia strobilella, 9
Dioryctria abietivorella, 9, 85
Dioryctria reniculelloides, 9, 29
Herculia thymetusalis, 9
Foliage, in
Miners; moths
Archips packardiana, 29
Coleotechnites blastovora, 47
Coleotechnites piceaella, 47
Endothenia albolineana, 47
Foliage, on
Aphids, woolly
Adelges cooleyi, 11, 51

***Picea* continued**

- *Adelges lariciatus*, 51
- Beetles, longhorned
  - *Monochamus scutellatus*, 87
  - *Monochamus notatus*, 87
- Budworms and their allies
  - *Choristoneura fumiferana*, 9, 15, 29, 47
  - *Dioryctria abietivorella*, 9, 85
  - *Dioryctria reniculelloides*, 9, 29
- Caterpillars
  - *Eilema bicolor*, 19
  - *Feralia jocosa*, 17
  - *Idia aemula*, 17
  - *Lymantria dispar*, 127
  - *Orgyia antiqua*, 19, 127
  - *Panthea acronyctoides*, 19
- Leaftiers
  - *Archips packardiana*, 29
  - *Argyrotaenia occultana*, 29
  - *Herculia thymetusalis*, 9
- Loopers
  - *Anacamptodes vellivolata*, 25, 27
  - *Caripeta angustiorata*, 27
  - *Caripeta divisata*, 27
  - *Cladara limitaria*, 27
  - *Ectropis crepuscularia*, 27, 177
  - *Eufidonia notataria*, 27
  - *Eupithecia annulata*, 25
  - *Eupithecia filmata*, 25
  - *Eupithecia fletcherata*, 25
  - *Eupithecia luteata*, 25
  - *Eupithecia palpata*, 25
  - *Eupithecia transcanadata*, 25
  - *Hydriomena divisaria*, 25
  - *Itame exauspicata*, 181
  - *Lambdina fiscellaria*, 27
  - *Nematocampa limbata*, 21, 143
  - *Nepytia canosaria*, 23
  - *Pero morrisonaria*, 181
  - *Prochoerodes transversata*, 179
  - *Semiothisa signaria dispuncta*, 23
- Mites
  - *Oligonychus ununguis*, 31
- Sawflies
  - *Gilpinia hercyniae*, 33
  - *Neodiprion abietis*, 33, 35
  - *Pikonema alaskensis*, 33
  - *Pikonema dimmockii*, 33
  - *Pristiphora lena*, 33
- Scales
  - *Chionaspis pinifoliae*, 41
  - *Physokermes piceae*, 71
- Weevils
  - *Hylobius pales*, 99
  - *Hylobius pinicola*, 99
  - *Hylobius warreni*, 99
  - *Otiorhynchus ovatus*, 95
  - *Otiorhynchus sulcatus*, 95

Roots, on
- Weevils
  - *Hylobius pales*, 99
  - *Hylobius pinicola*, 99
  - *Hylobius warreni*, 99

Roots or basal stem, under bark
- Weevils
  - *Hylobius pales*, 99
  - *Hylobius pinicola*, 99
  - *Hylobius warreni*, 99

Seedlings, on roots or stems
- Caterpillars
  - *Nomophila nearctica*, 97
  - *Ochropleura plecta*, 97
- Maggots
  - *Tipula*, 97
- Weevils
  - *Hylobius pales*, 99
  - *Otiorhynchus ovatus*, 95
  - *Otiorhynchus sulcatus*, 95

Trunk or large branches, in wood
- Borers, roundheaded
  - *Judolia montivagens*, 87
  - *Monochamus notatus*, 87
  - *Monochamus scutellatus*, 87
  - *Pygoleptura nigrella*, 89
  - *Semanotus litigiosus*, 89
  - *Tetropium cinnamopterum*, 87
  - *Tetropium cinnamopterum parvulum*, 87
- Horntails
  - *Sirex cyaneus*, 91
  - *Urocerus albicornis*, 91
  - *Urocerus cressoni*, 91
  - *Urocerus gigas flavicornis*, 91
  - *Xeris spectrum spectrum*, 91

Trunk or large branches, under bark
- Beetles, bark
  - *Dendroctonus rufipennis*, 77
  - *Dendroctonus valens*, 79
  - *Ips pini*, 81
- Borers, flatheaded
  - *Melanophila acuminata*, 89
  - *Melanophila drummondi*, 89
- Borers, roundheaded
  - *Judolia montivagens*, 89
  - *Semanotus litigiosus*, 89
  - *Pygoleptura nigrella*, 89
- Moths, pitch
  - *Synanthedon novaroensis*, 83

Twigs or small branches, on
- Beetles, longhorned
  - *Monochamus scutellatus*, 87
  - *Monochamus notatus*, 87
- Scales
  - *Physokermes piceae*, 71
- Spittlebugs
  - *Aphrophora gelida*, 65
- Weevils
  - *Pissodes strobi*, 73
  - *Hylobius pinicola*, 99
  - *Hylobius warreni*, 99
  - *Otiorhynchus ovatus*, 46
  - *Otiorhynchus sulcatus*, 95

Twigs or small branches, under bark
- Gall formers
  - *Mayetiola piceae*, 45
- Weevils, terminal
  - *Pissodes strobi*, 71

***Picea engelmannii* Parry** (Engelmann spruce)

Buds or shoots, in
- Budworms and their allies
  - *Acleris variana*, 15
  - *Choristoneura biennis*, 15

- ***Picea engelmannii* continued**
      - *Choristoneura occidentalis*, 15
      - *Zeiraphera canadensis*, 29
      - *Zeiraphera improbana*, 29
    - Gall formers; adelgids
      - *Adelges cooleyi*, 11, 51
      - *Pineus similis*, 51
  - Cones or seeds
    - Chalcids
      - *Megastigmus*, 7
    - Maggots
      - *Dasineura canadensis*, 7
      - *Dasineura rachiphaga*, 7
      - *Delia anthracina*, 7
    - Moths
      - *Cydia strobilella*, 9
  - Foliage, in
    - Miners; moths
      - *Choristoneura biennis*, 15
      - *Choristoneura occidentalis*, 15
  - Foliage, on
    - Aphids
      - *Cinara*, 63
    - Aphids, woolly
      - *Adelges cooleyi*, 11, 51
      - *Pineus similis*, 51
    - Budworms and their allies
      - *Acleris variana*, 15
      - *Choristoneura biennis*, 15
      - *Choristoneura occidentalis*, 15
      - *Epinotia radicana*, 29
      - *Zeiraphera canadensis*, 29
      - *Zeiraphera improbana*, 29
    - Caterpillars
      - *Dasychira grisefacta*, 19
      - *Dasychira plagiata*, 19
      - *Eilema bicolor*, 19
      - *Feralia jocosa*, 17
      - *Lithophane innominata*, 137
      - *Melanchra pulverulenta*, 17
      - *Orgyia antiqua*, 19, 127
      - *Palthis angulalis*, 17
      - *Syngrapha alias interalia*, 17
      - *Syngrapha viridisigma*, 17
    - Leaftiers
      - *Archips packardiana*, 29
    - Loopers
      - *Caripeta divisata*, 27
      - *Cladara limitaria*, 27
      - *Ectropis crepuscularia*, 27, 177
      - *Hydriomena furcata*, 185
      - *Hypagyrtis piniata*, 27
      - *Nepytia freemani*, 23
      - *Protoboarmia porcelaria indicataria*, 23, 27
      - *Semiothisa signaria dispuncta*, 23
    - Sawflies
      - *Pikonema alaskensis*, 33
    - Sawflies, webspinning
      - *Cephalcia provancheri*, 39
  - Trunk or large branches, in wood
    - Borers, miscellaneous
      - *Serropalpus substriatus*, 89
    - Borers, roundheaded
      - *Tetropium cinnamopterum parvulum*, 87
    - Horntails
      - *Sirex cyaneus*, 91
      - *Xeris spectrum spectrum*, 91
  - Trunk or large branches, under bark
    - Beetles, bark
      - *Dendroctonus rufipennis*, 77
      - *Ips borealis*, 81
      - *Ips perturbatus*, 81
      - *Ips pini*, 81
    - Borers, roundheaded
      - *Tetropium cinnamopterum parvulum*, 87
    - Moths, pitch
      - *Synanthedon novaroensis*, 83
    - Weevils
      - *Pissodes schwarzi*, 73
  - Twigs or small branches, on bark
    - Aphids, woolly
      - *Adelges cooleyi*, 11, 51
      - *Pineus similis*, 51
    - Spittlebugs
      - *Aphrophora gelida*, 65
  - Twigs or small branches, under bark
    - Weevils, terminal
      - *Pissodes strobi*, 73

- ***Picea glauca* (Moench) Voss** (white spruce)
  - Buds or shoots, in
    - Budworms and their allies
      - *Acleris variana*, 15
      - *Archips alberta*, 9
      - *Choristoneura biennis*, 15
      - *Choristoneura fumiferana*, 9, 15, 29, 47
      - *Choristoneura occidentalis*, 15
      - *Choristoneura pinus*, 9, 13
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria reniculelloides*, 9, 29
      - *Zeiraphera canadensis*, 29
      - *Zeiraphera improbana*, 29
      - *Zeiraphera unfortunana*, 29
    - Gall formers; adelgids
      - *Adelges cooleyi*, 11, 51
      - *Adelges lariciatus*, 51
      - *Adelges strobilobius*, 51
      - *Pineus pinifoliae*, 51
      - *Pineus similis*, 51
    - Midges, bud
      - *Rhabdophaga swainei*, 53
  - Cones or seeds
    - Chalcids
      - *Megastigmus atedius atedius*, 7
    - Maggots
      - *Dasineura canadensis*, 7
      - *Dasineura rachiphaga*, 7
      - *Delia anthracina*, 7
      - *Mayetiola carpophaga*, 7
      - *Resseliella*, 7
    - Moths
      - *Archips alberta*, 9
      - *Choristoneura biennis*, 15
      - *Choristoneura fumiferana*, 9, 15, 29, 47
      - *Choristoneura occidentalis*, 15
      - *Cydia strobilella*, 9
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria reniculelloides*, 9, 29
      - *Herculia thymetusalis*, 9
  - Foliage, in
    - Miners; moths
      - *Archips packardiana*, 29

***Picea glauca* continued**
    - *Choristoneura biennis*, 15
    - *Choristoneura fumiferana*, 9, 15, 29, 47
    - *Choristoneura occidentalis*, 15
    - *Coleotechnites blastovora*, 47
    - *Coleotechnites piceaella*, 47
    - *Endothenia albolineana*, 47
- Foliage, on
  - Aphids, woolly
    - *Adelges cooleyi*, 11, 51
    - *Adelges lariciatus*, 51
    - *Pineus coloradensis*, 11, 97
  - Beetles, longhorned
    - *Monochamus scutellatus*, 87
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Choristoneura biennis*, 15
    - *Choristoneura fumiferana*, 9, 15, 29, 47
    - *Choristoneura occidentalis*, 15
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
    - *Epinotia radicana*, 29
    - *Zeiraphera canadensis*, 29
    - *Zeiraphera improbana*, 29
    - *Zeiraphera unfortunana*, 29
  - Caterpillars
    - *Anomogyna elimata*, 17
    - *Anomogyna perquiritata*, 17
    - *Clemensia albata*, 17
    - *Dasychira grisefacta*, 19
    - *Dasychira plagiata*, 19
    - *Dasychira vagans*, 127
    - *Eilema bicolor*, 19
    - *Elaphria versicolor*, 17
    - *Feralia jocosa*, 17
    - *Idia aemula*, 17
    - *Incisalia niphon clarki*, 21
    - *Lithophane innominata*, 137
    - *Orgyia antiqua*, 19, 127
    - *Orgyia leucostigma*, 19, 127
    - *Orthosia hibisci*, 137
    - *Palthis angulalis*, 17
    - *Panthea acronyctoides*, 19
    - *Sphinx gordius*, 21
    - *Syngrapha alias interalia*, 17
    - *Syngrapha rectangula*, 17
    - *Syngrapha viridisigma*, 17
    - *Tolype laricis*, 19
  - Leaf rollers
    - *Choristoneura rosaceana*, 169
  - Leaftiers
    - *Archips packardiana*, 29
    - *Argyrotaenia occultana*, 29
    - *Herculia thymetusalis*, 9
  - Loopers
    - *Anacamptodes vellivolata*, 25, 27
    - *Anagoga occiduaria*, 185
    - *Anavitrinelia pampinaria*, 179
    - *Campaea perlata*, 177
    - *Caripeta angustiorata*, 27
    - *Caripeta divisata*, 127
    - *Cladara limitaria*, 27
    - *Ectropis crepuscularia*, 27, 177
    - *Eufidonia discospilata*, 27
    - *Eufidonia notataria*, 27
    - *Eupithecia annulata*, 25
    - *Eupithecia fletcherata*, 25
    - *Eupithecia luteata*, 25
    - *Eutrapela clemataria*, 179
    - *Hydriomena divisaria*, 25
    - *Hydriomena furcata*, 185
    - *Hypagyrtis piniata*, 27
    - *Itame loricaria julia*, 181
    - *Lambdina fiscellaria*, 27, 177
    - *Melanolophia signataria*, 185
    - *Nematocampa limbata*, 21, 143
    - *Nemoria mimosaria*, 143
    - *Nepytia canosaria*, 23
    - *Pero morrisonaria*, 181
    - *Probole amicaria*, 179
    - *Prochoerodes transversata*, 179
    - *Protoboarmia porcelaria indicataria*, 23, 27
    - *Semiothisa oweni*, 23
    - *Semiothisa signaria dispuncta*, 23
  - Mites
    - *Oligonychus ununguis*, 31
  - Sawflies
    - *Gilpinia hercyniae*, 33
    - *Neodiprion abietis*, 33, 35
    - *Pikonema alaskensis*, 33
    - *Pikonema dimmockii*, 33
    - *Pristiphora lena*, 33
  - Sawflies, webspinning
    - *Cephalcia fascipennis*, 39
    - *Cephalcia provancheri*, 39
  - Scales
    - *Chionaspis pinifoliae*, 41
    - *Physokermes piceae*, 71
  - Weevils
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
    - *Otiorhynchus ovatus*, 95
- Roots or basal stem, under bark
  - Weevils
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
- Seedlings, on roots or stems
  - Weevils
    - *Otiorhynchus ovatus*, 95
- Trunk or large branches, in wood
  - Ants, carpenter
    - *Camponotus herculeanus*, 93
  - Borers, roundheaded
    - *Monochamus scutellatus*, 87
    - *Tetropium cinnamopterum*, 87
    - *Tetropium cinnamopterum parvulum*, 87
  - Borers, miscellaneous
    - *Serropalpus substriatus*, 89
  - Horntails
    - *Sirex cyaneus*, 91
    - *Urocerus gigas flavicornis*, 91
- Trunk or large branches, under bark
  - Beetles, bark
    - *Dendroctonus rufipennis*, 77
    - *Ips borealis*, 81
    - *Ips perturbatus*, 123
    - *Ips pini*, 81
  - Borers, roundheaded
    - *Monochamus scutellatus*, 87
    - *Tetropium cinnamopterum*, 87
    - *Tetropium cinnamopterum parvulum*, 87

***Picea glauca* continued**
- Moths, pitch
  - *Dioryctria abietivorella*, 9, 85
  - *Synanthedon novaroensis*, 83
  - *Synanthedon pini*, 83
- Twigs or small branches, on bark
  - Aphids
    - *Cinara*, 63
  - Aphids, woolly
    - *Adelges cooleyi*, 11, 51
    - *Adelges laricìatus*, 51
    - *Pineus similis*, 51
  - Beetles, longhorned
    - *Monochamus scutellatus*, 87
  - Scales
    - *Physokermes piceae*, 71
  - Spittlebugs
    - *Aphrophora gelida*, 65
    - *Aphrophora saratogensis*, 65
  - Weevils
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
    - *Otiorhynchus ovatus*, 95
    - *Pissodes strobi*, 73
- Twigs or small branches, under bark
  - Gall formers
    - *Mayetiola piceae*, 45
  - Moths, twig
    - *Dioryctria abietivorella*, 9, 85
  - Weevils, terminal
    - *Pissodes strobi*, 73

***Picea glauca* (Moench) Voss var. *albertiana* (S. Brown) Sargent** (western white spruce)
- Buds or shoots, in
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Choristoneura biennis*, 15
    - *Choristoneura occidentalis*, 15
    - *Zeiraphera improbana*, 29
- Foliage, in
  - Miners; moths
    - *Choristoneura biennis*, 15
    - *Choristoneura occidentalis*, 15
- Foliage, on
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Choristoneura biennis*, 15
    - *Choristoneura occidentalis*, 15
    - *Epinotia radicana*, 29
    - *Zeiraphera improbana*, 29
  - Caterpillars
    - *Dasychira grisefacta*, 19
    - *Feralia jocosa*, 17
    - *Syngrapha alias interalia*, 17
    - *Syngrapha viridisigma*, 17
  - Loopers
    - *Caripeta divisata*, 27
    - *Cladara limitaria*, 27
    - *Nepytia umbrosaria nigrovenaria*, 23
    - *Pero morrisonaria*, 181
    - *Protoboarmia porcelaria indicataria*, 27

***Picea mariana* (Miller) Britton, Sterns & Poggenburg** (black spruce)
- Buds or shoots, in
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Archips alberta*, 9
    - *Choristoneura fumiferana*, 9, 15, 29, 47
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
    - *Zeiraphera canadensis*, 29
  - Midges, bud
    - *Rhabdophaga swainei*, 53
  - Gall formers; adelgids
    - *Adelges laricìatus*, 51
    - *Adelges strobilobius*, 51
    - *Pineus pinifoliae*, 51
    - *Pineus similis*, 51
- Cones or seeds
  - Maggots
    - *Dasineura canadensis*, 7
    - *Dasineura rachiphaga*, 7
    - *Delia anthracina*, 7
  - Moths
    - *Archips alberta*, 9
    - *Cydia strobilella*, 9
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
    - *Herculia thymetusalis*, 9
- Foliage, in
  - Miners; moths
    - *Archips alberta*, 9
    - *Choristoneura fumiferana*, 9, 15, 29, 47
    - *Coleotechnites piceaella*, 47
    - *Endothenia albolineana*, 47
- Foliage, on
  - Beetles, longhorned
    - *Monochamus scutellatus*, 87
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Choristoneura fumiferana*, 9, 15, 29, 47
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
    - *Epinotia radicana*, 29
    - *Zeiraphera canadensis*, 29
  - Caterpillars
    - *Anomogyna elimata*, 17
    - *Anomogyna perquiritata*, 17
    - *Dasychira plagiata*, 19
    - *Dasychira vagans*, 127
    - *Eilema bicolor*, 19
    - *Elaphria versicolor*, 17
    - *Feralia jocosa*, 17
    - *Idia aemula*, 17
    - *Orgyia antiqua*, 19, 127
    - *Orthosia hibisci*, 137
    - *Palthis angulalis*, 17
    - *Panthea acronyctoides*, 19
    - *Syngrapha alias interalia*, 17
    - *Syngrapha rectangula*, 17
    - *Syngrapha viridisigma*, 17
    - *Tolype laricis*, 19
  - Leaftiers
    - *Archips packardiana*, 29
    - *Argyrotaenia occultana*, 29
    - *Herculia thymetusalis*, 9
  - Loopers
    - *Anacamptodes vellivolata*, 25, 27

***Picea mariana* continued**
- *Caripeta divisata*, 27
- *Cladara limitaria*, 27
- *Ectropis crepuscularia*, 27, 177
- *Eufidonia discospilata*, 27
- *Eufidonia notataria*, 27
- *Eupithecia fletcherata*, 25
- *Eupithecia gibsonata*, 25
- *Eupithecia luteata*, 25
- *Hydriomena divisaria*, 25
- *Hypagyrtis piniata*, 27
- *Lambdina fiscellaria*, 27, 177
- *Nepytia canosaria*, 23
- *Prochoerodes transversata*, 179
- *Protoboarmia porcelaria indicataria*, 23, 27
- *Semiothisa signaria dispuncta*, 23

- Sawflies
  - *Gilpinia hercyniae*, 33
  - *Neodiprion abietis*, 33, 35
  - *Pikonema alaskensis*, 33
- Sawflies, webspinning
  - *Cephalcia provancheri*, 39

Trunk or large branches, in wood
- Borers, roundheaded
  - *Monochamus scutellatus*, 87

Trunk or large branches, under bark
- Moths, pitch
  - *Dioryctria abietivorella*, 9, 85

Twigs or small branches, on bark
- Aphids, woolly
  - *Adelges lariciatus*, 51
  - *Adelges strobilobius*, 51
  - *Pineus similis*, 51
- Beetles, longhorned
  - *Monochamus scutellatus*, 87
- Spittlebugs
  - *Aphrophora gelida*, 65

Twigs or small branches, under bark
- Moths, twig
  - *Dioryctria abietivorella*, 9, 85

***Picea pungens* Engelmann** (blue spruce)

Buds or shoots, in
- Budworms and their allies
  - *Acleris variana*, 15
  - *Choristoneura fumiferana*, 9, 15, 29, 47
  - *Choristoneura pinus*, 9, 13
  - *Dioryctria abietivorella*, 9, 85
  - *Dioryctria reniculelloides*, 9, 29
  - *Zeiraphera canadensis*, 29
- Gall formers; adelgids
  - *Adelges cooleyi*, 11, 51
  - *Adelges lariciatus*, 51
  - *Pineus similis*, 51

Cones or seeds
- Chalcids
  - *Megastigmus*, 7
- Moths
  - *Cydia strobilella*, 9
  - *Dioryctria abietivorella*, 9, 83
  - *Dioryctria reniculelloides*, 9, 29

Foliage, in
- Miners; moths
  - *Choristoneura fumiferana*, 9, 15, 29, 47
  - *Coleotechnites piceaella*, 47
  - *Endothenia albolineana*, 47

Foliage, on
- Aphids, woolly
  - *Adelges cooleyi*, 11, 51
  - *Adelges lariciatus*, 51
  - *Pineus pinifoliae*, 51
  - *Pineus similis*, 51
- Budworms and their allies
  - *Acleris variana*, 15
  - *Choristoneura fumiferana*, 9, 15, 29, 47
  - *Choristoneura pinus*, 9, 13
  - *Dioryctria abietivorella*, 9, 85
  - *Dioryctria reniculelloides*, 9, 29
  - *Epinotia radicana*, 29
  - *Zeiraphera canadensis*, 29
- Caterpillars
  - *Dasychira plagiata*, 19
  - *Idia aemula*, 17
- Leaftiers
  - *Archips packardiana*, 29
- Mites
  - *Oligonychus ununguis*, 31
- Sawflies
  - *Pikonema alaskensis*, 33
- Sawflies, webspinning
  - *Cephalcia fascipennis*, 39
  - *Cephalcia provancheri*, 39
- Scales
  - *Chionaspis pinifoliae*, 41
- Weevils
  - *Otiorhynchus ovatus*, 95

Seedlings, on roots or stems
- Weevils
  - *Otiorhynchus ovatus*, 95

Trunk or large branches, in wood
- Horntails
  - *Xeris spectrum spectrum*, 91

Trunk or large branches, under bark
- Moths, pitch
  - *Dioryctria abietivorella*, 9, 83
- Weevils
  - *Pissodes schwarzi*, 73

Twigs or small branches, on bark
- Aphids
  - *Cinara*, 63
- Aphids, woolly
  - *Adelges cooleyi*, 11, 51
  - *Adelges lariciatus*, 51
  - *Pineus similis*, 51
- Weevils
  - *Otiorhynchus ovatus*, 95

Twigs or small branches, under bark
- Moths
  - *Dioryctria abietivorella*, 9, 85
- Weevils, terminal
  - *Pissodes strobi*, 73

Pine (see *Pinus)*

Pinus (pine)

Buds or shoots, in
- Moths, tip
  - *Rhyacionia buoliana*, 57

Cones or seeds
- Moths
  - *Choristoneura pinus*, 9, 13
  - *Cydia toreuta*, 9
  - *Dioryctria abietivorella*, 9, 85

Pinus **continued**
    - *Dioryctria reniculelloides*, 9, 29
  - Cones, staminate
    - Moths
      - *Choristoneura pinus*, 9, 13
      - *Dioryctria reniculelloides*, 9, 29
    - Sawflies
      - *Xyela*, 7
  - Foliage, in
    - Miners; moths
      - *Rhyacionia buoliana*, 57
  - Foliage, on
    - Aphids, woolly
      - *Pineus coloradensis*, 11, 97
    - Beetles, longhorned
      - *Monochamus scutellatus*, 87
    - Beetles, scarab
      - *Dichelonyx subvittata*, 115
    - Budworms and their allies
      - *Choristoneura pinus*, 9, 13
    - Bugs, stink
      - *Banasa dimidiata*, 65
      - *Chlorochroa persimilis*, 65
    - Caterpillars
      - *Dasychira grisefacta*, 19
      - *Dasychira pinicola*, 19
      - *Lymantria dispar*, 127
      - *Panthea acronyctoides*, 19
      - *Panthea furcilla*, 19
      - *Panthea pallescens*, 19
    - Katydids
      - *Scudderia curvicauda*, 187
    - Loopers
      - *Anacamptodes vellivolata*, 25, 27
      - *Campaea perlata*, 177
      - *Caripeta angustiorata*, 27
      - *Caripeta divisata*, 27
      - *Eufidonia convergaria*, 27
      - *Eupithecia luteata*, 25
      - *Eupithecia palpata*, 25
      - *Eupithecia transcanadata*, 25
      - *Lambdina fiscellaria*, 27, 177
      - *Nematocampa limbata*, 21, 143
      - *Nepytia canosaria*, 23
      - *Prochoerodes transversata*, 179
      - *Semiothisa signaria dispuncta*, 23
      - *Sicya macularia*, 181
    - Mites
      - *Oligonychus ununguis*, 31
    - Sawflies
      - *Neodiprion abbotii*, 35
      - *Neodiprion nanulus nanulus*, 35
      - *Neodiprion swainei*, 35
    - Scales
      - *Chionaspis pinifoliae*, 19
      - *Physokermes piceae*, 71
    - Weevils
      - *Hylobius pales*, 99
      - *Hylobius pinicola*, 99
      - *Hylobius warreni*, 99
      - *Otiorhynchus ovatus*, 95
  - Roots, on bark
    - Weevils
      - *Hylobius congener*, 99
      - *Hylobius pales*, 99
      - *Hylobius pinicola*, 99
      - *Hylobius warreni*, 99
  - Roots or basal stem, under bark
    - Weevils
      - *Hylobius congener*, 99
      - *Hylobius pales*, 99
      - *Hylobius pinicola*, 99
      - *Hylobius warreni*, 99
  - Seedlings, on roots or stems
    - Grasshoppers
      - *Melanoplus bivittatus*, 187
    - Weevils
      - *Hylobius congener*, 99
      - *Hylobius pales*, 99
      - *Otiorhynchus ovatus*, 95
    - White grubs
      - *Phyllophaga anxia*, 115
      - *Phyllophaga drakii*, 115
      - *Phyllophaga nitida*, 115
      - *Phyllophaga rugosa*, 115
  - Trunk or large branches, in wood
    - Ants, carpenter
      - *Camponotus*, 93
    - Borers, roundheaded
      - *Judolia montivagens*, 89
      - *Monochamus scutellatus*, 87
      - *Pygoleptura nigrella*, 89
      - *Tetropium cinnamopterum*, 87
    - Horntails
      - *Sirex cyaneus*, 91
      - *Urocerus albicornis*, 91
      - *Urocerus cressoni*, 91
      - *Urocerus gigas flavicornis*, 91
      - *Xeris spectrum spectrum*, 91
  - Trunk or large branches, under bark
    - Beetles, bark
      - *Dendroctonus ponderosae*, 75
      - *Dendroctonus valens*, 79
      - *Ips pini*, 81
    - Borers, flatheaded
      - *Chrysobothris*, 85
      - *Chrysobothris cribraria*, 85
      - *Melanophila acuminata*, 89
    - Borers, roundheaded
      - *Judolia montivagens*, 89
      - *Monochamus scutellatus*, 87
      - *Pygoleptura nigrella*, 89
      - *Tetropium cinnamopterum*, 87
    - Moths, pitch
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria cambiicola*, 85
      - *Dioryctria zimmermani*, 85
      - *Synanthedon pini*, 83
    - Weevils
      - *Hylobius congener*, 99
  - Twigs or small branches, on bark
    - Aphids, woolly
      - *Pineus coloradensis*, 11, 97
    - Beetles, longhorned
      - *Monochamus scutellatus*, 87
    - Spittlebugs
      - *Aphrophora gelida*, 65
    - Weevils
      - *Hylobius pales*, 99
      - *Hylobius pinicola*, 99
      - *Hylobius warreni*, 99
      - *Otiorhynchus ovatus*, 95

Pinus continued
      - *Pissodes strobi*, 73
  - Twigs or small branches, under bark
    - Weevils, terminal
      - *Pissodes strobi*, 73

Pinus albicaulis Engelmann (whitebark pine)
- Foliage, in
  - Miners; moths
    - *Argyrotaenia tabulana*, 43
- Foliage, on
  - Tube makers
    - *Argyrotaenia tabulana*, 43
- Trunk or large branches, under bark
  - Beetles, bark
    - *Dendroctonus ponderosae*, 75
    - *Ips pini*, 81

Pinus banksiana Lambert (jack pine)
- Buds or shoots, in
  - Beetles, bark
    - *Pityophthorus boycei*, 55
  - Budworms and their allies
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
  - Gall formers; wasps
    - *Eurytoma calycis*, 45
  - Midges, pitch
    - *Cecidomyia piniinopis*, 67
    - *Cecidomyia resinicola*, 67
  - Moths, tip
    - *Rhyacionia adana*, 57
    - *Rhyacionia buoliana*, 57
    - *Rhyacionia granti*, 57
    - *Rhyacionia sonia*, 57
  - Weevils, terminal
    - *Pissodes terminalis*, 73
- Buds or shoots, on
  - Gall formers; mites
    - *Trisetacus gemmavitians*, 27
  - Weevils
    - *Pissodes terminalis*, 73
- Cones or seeds
  - Moths
    - *Choristoneura pinus*, 9, 13
    - *Cydia toreuta*, 9
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
    - *Herculia thymetusalis*, 9
- Cones, staminate
  - Moths
    - *Choristoneura pinus*, 9, 13
- Foliage, in
  - Gall formers; wasps
    - *Eurytoma calycis*, 45
  - Miners; moths
    - *Argyrotaenia tabulana*, 43
    - *Coleotechnites*, 47
    - *Rhyacionia adana*, 57
    - *Tetralopha robustella*, 29
- Foliage, on
  - Beetles, longhorned
    - *Monochamus scutellatus*, 87
  - Borers, flatheaded
    - *Buprestis intricata*, 87
  - Budworms and their allies
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
  - Caterpillars
    - *Anomogyna elimata*, 17
    - *Anomogyna perquiritata*, 17
    - *Dasychira plagiata*, 19
    - *Dasychira vagans*, 127
    - *Eilema bicolor*, 19
    - *Elaphria versicolor*, 17
    - *Feralia jocosa*, 17
    - *Incisalia eryphon*, 21
    - *Incisalia niphon clarki*, 21
    - *Lapara bombycoides*, 21
    - *Orgyia antiqua*, 19, 127
    - *Orthosia hibisci*, 137
    - *Palthis angulalis*, 17
    - *Panthea acronyctoides*, 19
    - *Panthea furcilla*, 19
    - *Panthea pallescens*, 19
    - *Syngrapha alias interalia*, 17
    - *Syngrapha viridisigma*, 17
    - *Tolype laricis*, 19
    - *Zale duplicata*, 17
  - Leaftiers
    - *Archips packardiana*, 29
    - *Argyrotaenia tabulana*, 43
    - *Herculia thymetusalis*, 9
  - Loopers
    - *Anacamptodes vellivolata*, 25, 27
    - *Campaea perlata*, 177
    - *Caripeta angustiorata*, 27
    - *Caripeta divisata*, 27
    - *Cladara limitaria*, 27
    - *Eufidonia notataria*, 27
    - *Eupithecia gibsonata*, 25
    - *Eupithecia palpata*, 25
    - *Hypagyrtis piniata*, 27
    - *Lambdina fiscellaria*, 27, 177
    - *Nematocampa limbata*, 21, 143
    - *Nepytia canosaria*, 23
    - *Prochoerodes transversata*, 179
    - *Protoboarmia porcelaria indicataria*, 27
    - *Semiothisa bicolorata*, 23, 27
    - *Semiothisa oweni*, 23
    - *Semiothisa signaria dispuncta*, 23
  - Sawflies
    - *Diprion similis*, 35
    - *Neodiprion dubiosus*, 35
    - *Neodiprion maurus*, 35
    - *Neodiprion nanulus nanulus*, 35
    - *Neodiprion pratti banksianae*, 35
    - *Neodiprion rugifrons*, 35
    - *Neodiprion sertifer*, 35
    - *Neodiprion swainei*, 35
  - Sawflies, webspinning
    - *Acantholyda* nr. *tesselata*, 39
  - Tube makers
    - *Argyrotaenia tabulana*, 43
  - Webworms and their allies
    - *Tetralopha robustella*, 29
  - Weevils
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99

***Pinus banksiana* continued**
- Roots, on bark
  - Cicadas
    - *Okanagana rimosa*, 65
  - Weevils
    - *Hylobius pales*, 99
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
- Roots or basal stem, under bark
  - Beetles, bark
    - *Dendroctonus murrayanae*, 79
  - Weevils
    - *Hylobius pales*, 99
    - *Hylobius pinicola*, 99
    - *Hylobius radicis*, 99
    - *Hylobius warreni*, 99
- Seedlings, on roots or stems
  - Grasshoppers
    - *Melanoplus bivittatus*, 187
  - Weevils
    - *Hylobius pales*, 99
  - White grubs
    - *Phyllophaga*, 97
    - *Phyllophaga anxia*, 115
    - *Phyllophaga drakii*, 115
    - *Phyllophaga nitida*, 115
    - *Phyllophaga rugosa*, 115
- Trunk or large branches, in wood
  - Borers, roundheaded
    - *Monochamus scutellatus*, 87
    - *Pygoleptura nigrella*, 89
  - Horntails
    - *Xeris spectrum spectrum*, 91
- Trunk or large branches, under bark
  - Beetles, bark
    - *Dendroctonus murrayanae*, 79
    - *Dendroctonus valens*, 79
    - *Ips pini*, 81
  - Borers, roundheaded
    - *Monochamus scutellatus*, 87
    - *Pygoleptura nigrella*, 89
  - Moths, pitch
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria banksiella*, 29, 85
    - *Dioryctria cambiicola*, 85
  - Moths, pitch nodule
    - *Petrova albicapitana*, 69
- Twigs or small branches, in wood
  - Borers, moth
    - *Eucosma gloriola*, 59
- Twigs or small branches, on bark
  - Aphids
    - *Cinara*, 63
  - Beetles, longhorned
    - *Monochamus scutellatus*, 87
  - Gall formers; mites
    - *Trisetacus gemmavitians*, 45
  - Midges, pitch
    - *Cecidomyia piniinopis*, 67
    - *Cecidomyia resinicola*, 67
  - Scales
    - *Toumeyella parvicornus*, 71
  - Spittlebugs
    - *Aphrophora cribrata*, 65
    - *Aphrophora gelida*, 65
    - *Aphrophora saratogensis*, 65
  - Weevils
    - *Hylobius pales*, 99
    - *Hylobius pinicola*, 99
    - *Hylobius radicis*, 99
    - *Hylobius warreni*, 99
    - *Pissodes strobi*, 73
- Twigs or small branches, under bark
  - Moths, pitch nodule
    - *Petrova albicapitana*, 69
    - *Petrova metallica*, 69
  - Moths, twig
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria banksiella*, 29, 85
  - Weevils, terminal
    - *Pissodes strobi*, 73
    - *Pissodes terminalis*, 73

***Pinus contorta* Douglas var. *latifolia* Engelmann** (lodgepole pine)
- Buds or shoots, in
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Choristoneura lambertiana*, 13
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
  - Weevils, terminal
    - *Pissodes terminalis*, 73
- Buds or shoots, on
  - Weevils
    - *Pissodes terminalis*, 73
- Cones or seeds
  - Moths
    - *Choristoneura pinus*, 9, 13
    - *Cydia toreuta*, 9
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
    - *Herculia thymetusalis*, 9
- Cones, staminate
  - Moths
    - *Choristoneura pinus*, 9, 13
  - Sawflies
    - *Xyela bakeri*, 7
- Foliage, in
  - Miners; moths
    - *Argyrotaenia tabulana*, 43
    - *Coleotechnites starki*, 47
- Foliage, on
  - Aphids, woolly
    - *Pineus coloradensis*, 11, 97
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Choristoneura lambertiana*, 13
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
    - *Epinotia radicana*, 29
  - Caterpillars
    - *Anomogyna elimata*, 17
    - *Anomogyna perquiritata*, 17
    - *Dasychira grisefacta*, 19
    - *Dasychira plagiata*, 19
    - *Eilema bicolor*, 19
    - *Feralia jocosa*, 17
    - *Incisalia eryphon*, 21
    - *Lithophane innominata*, 137
    - *Melanchra pulverulenta*, 17

***Pinus contorta* continued**
    - *Orgyia antiqua*, 19, 127
    - *Palthis angulalis*, 17
    - *Panthea acronyctoides*, 19
    - *Panthea furcilla*, 19
    - *Syngrapha viridisigma*, 17
    - *Zale duplicata*, 17
  - Leaftiers
    - *Archips packardiana*, 29
    - *Argyrotaenia occultana*, 29
    - *Argyrotaenia tabulana*, 43
    - *Herculia thymetusalis*, 9
  - Loopers
    - *Campaea perlata*, 177
    - *Caripeta angustiorata*, 27
    - *Caripeta divisata*, 27
    - *Cladara limitaria*, 27
    - *Eufidonia notataria*, 27
    - *Eupithecia palpata*, 25
    - *Hypagyrtis piniata*, 27
    - *Metanema inatomaria*, 177
    - *Nematocampa limbata*, 21, 143
    - *Nepytia umbrosaria nigrovenaria*, 23
    - *Pero morrisonaria*, 181
    - *Semiothisa bicolorata*, 23, 27
    - *Semiothisa signaria dispuncta*, 23
  - Sawflies
    - *Neodiprion abbotii*, 35
    - *Neodiprion nanulus contortae*, 35
  - Tube makers
    - *Argyrotaenia tabulana*, 43
  - Weevils
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
- Roots, on bark
  - Weevils
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
- Roots or basal stem, under bark
  - Beetles, bark
    - *Dendroctonus murrayanae*, 79
  - Weevils
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
- Seedlings, on roots or stems
  - Cutworms
    - *Ochropleura plecta*, 97
  - Aphids, woolly
    - *Pineus coloradensis*, 11, 97
- Trunk or large branches, in wood
  - Ants, carpenter
    - *Camponotus herculeanus*, 93
  - Borers, miscellaneous
    - *Serropalpus substriatus*, 89
  - Horntails
    - *Xeris spectrum spectrum*, 91
- Trunk or large branches, under bark
  - Beetles, bark
    - *Dendroctonus murrayanae*, 79
    - *Dendroctonus ponderosae*, 75
    - *Dendroctonus valens*, 79
    - *Ips pini*, 81
  - Borers, flatheaded
    - *Melanophila acuminata*, 89
  - Moths, pitch
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria cambiicola*, 85
    - *Synanthedon novaroensis*, 83
    - *Synanthedon sequoiae*, 83
  - Moths, pitch nodule
    - *Petrova albicapitana*, 69
    - *Petrova metallica*, 69
  - Weevils
    - *Pissodes approximatus*, 73
    - *Pissodes schwarzi*, 73
- Twigs or small branches, on bark
  - Aphids
    - *Cinara*, 63
  - Aphids, woolly
    - *Pineus coloradensis*, 11, 97
  - Midges, pitch
    - *Cecidomyia piniinopis*, 67
    - *Cecidomyia resinicola*, 67
  - Spittlebugs
    - *Aphrophora gelida*, 65
  - Weevils
    - *Hylobius pinicola*, 99
    - *Hylobius warreni*, 99
    - *Pissodes strobi*, 73
- Twigs or small branches, under bark
  - Moths, pitch nodule
    - *Petrova albicapitana*, 69
    - *Petrova metallica*, 69
  - Moths, twig
    - *Dioryctria abietivorella*, 9, 85
  - Weevils, terminal
    - *Pissodes strobi*, 73
    - *Pissodes terminalis*, 73

***Pinus flexilis* James** (limber pine)
- Buds or shoots, in
  - Budworms and their allies
    - *Choristoneura lambertiana*, 13
    - *Dioryctria abietivorella*, 9, 85
- Cones or seeds
  - Moths
    - *Dioryctria abietivorella*, 9, 85
- Foliage, on
  - Budworms and their allies
    - *Choristoneura lambertiana*, 13
    - *Dioryctria abietivorella*, 9, 85
  - Caterpillars
    - *Anomogyna elimata*, 17
    - *Incisalia eryphon*, 21
    - *Panthea furcilla*, 19
  - Loopers
    - *Caripeta angustiorata*, 27
- Trunk or large branches, under bark
  - Beetles, bark
    - *Dendroctonus ponderosae*, 75
    - *Dendroctonus valens*, 79
    - *Ips pini*, 81
  - Moths, pitch
    - *Dioryctria abietivorella*, 9, 85
    - *Synanthedon sequoiae*, 83
- Twigs or small branches, under bark
  - Moths, twig
    - *Dioryctria abietivorella*, 9, 85

***Pinus monticola* Douglas** (western white pine)
- Buds or shoots, in
  - Budworms and their allies
    - *Dioryctria abietivorella*, 9, 85

- ***Pinus monticola* continued**
  - Cones or seeds
    - Moths
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria cambiicola*, 85
  - Foliage, on
    - Aphids, woolly
      - *Pineus coloradensis*, 11, 97
      - *Pineus pinifoliae*, 51
    - Budworms and their allies
      - *Dioryctria abietivorella*, 9, 85
    - Caterpillars
      - *Dasychira grisefacta*, 19
      - *Dasychira plagiata*, 19
      - *Eilema bicolor*, 19
      - *Incisalia eryphon*, 21
      - *Papestra cristifera*, 137
    - Leaftiers
      - *Argyrotaenia tabulana*, 43
    - Loopers
      - *Cladara limitaria*, 27
      - *Erannis tiliaria*, 177
      - *Eupithecia annulata*, 25
      - *Itame exauspicata*, 181
      - *Nematocampa limbata*, 21, 143
      - *Nepytia umbrosaria nigrovenaria*, 23
    - Tube makers
      - *Argyrotaenia tabulana*, 43
  - Roots or basal stem, under bark
    - Weevils
      - *Hylobius warreni*, 99
  - Trunk or large branches, under bark
    - Beetles, bark
      - *Dendroctonus ponderosae*, 75
      - *Dendroctonus valens*, 79
      - *Ips pini*, 81
    - Moths, pitch
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria cambiicola*, 85
      - *Synanthedon novaroensis*, 83
      - *Synanthedon sequoiae*, 83
  - Twigs or small branches, on bark
    - Aphids, woolly
      - *Pineus coloradensis*, 11, 97
      - *Pineus pinifoliae*, 51
  - Twigs or small branches, under bark
    - Moths, twig
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria cambiicola*, 85

- ***Pinus resinosa* Aiton** (red pine)
  - Buds or shoots, in
    - Beetles, bark
      - *Pityophthorus fivazi*, 55
    - Budworms and their allies
      - *Choristoneura pinus*, 9, 13
      - *Dioryctria abietivorella*, 9, 85
    - Moths, tip
      - *Rhyacionia adana*, 57
      - *Rhyacionia buoliana*, 57
  - Cones or seeds
    - Moths
      - *Dioryctria abietivorella*, 9, 85
  - Foliage, in
    - Miners; moths
      - *Rhyacionia adana*, 57
      - *Rhyacionia buoliana*, 57
      - *Tetralopha robustella*, 29
  - Foliage, on
    - Aphids, woolly
      - *Pineus coloradensis*, 11, 97
    - Budworms and their allies
      - *Choristoneura pinus*, 9, 13
      - *Dioryctria abietivorella*, 9, 85
    - Caterpillars
      - *Acronicta lanceolaria*, 19
      - *Anomogyna elimata*, 17
      - *Anomogyna perquiritata*, 17
      - *Dasychira plagiata*, 19
      - *Dasychira vagans*, 127
      - *Elaphria versicolor*, 17
      - *Feralia jocosa*, 17
      - *Incisalia niphon clarki*, 21
      - *Lapara bombycoides*, 21
      - *Palthis angulalis*, 17
      - *Panthea acronyctoides*, 19
      - *Panthea furcilla*, 19
      - *Panthea pallescens*, 19
      - *Tolype laricis*, 19
      - *Zale duplicata*, 17
    - Loopers
      - *Caripeta divisata*, 27
      - *Eufidonia notataria*, 27
      - *Eupithecia palpata*, 25
      - *Hypagyrtis piniata*, 27
      - *Lambdina fiscellaria*, 27, 177
      - *Nepytia canosaria*, 23
      - *Protoboarmia porcelaria indicataria*, 27
      - *Semiothisa bicolorata*, 23
      - *Semiothisa oweni*, 23
      - *Semiothisa signaria dispuncta*, 23
    - Sawflies
      - *Diprion similis*, 35
      - *Neodiprion abbotii*, 35
      - *Neodiprion nanulus nanulus*, 35
      - *Neodiprion sertifer*, 35
      - *Neodiprion swainei*, 35
    - Sawflies, webspinning
      - *Acantholyda zappei*, 39
    - Scales
      - *Chionaspis pinifoliae*, 41
    - Webworms and their allies
      - *Tetralopha robustella*, 29
    - Weevils
      - *Hylobius warreni*, 99
      - *Otiorhynchus ovatus*, 95
  - Roots or basal stem, under bark
    - Weevils
      - *Hylobius pales*, 99
      - *Hylobius pinicola*, 99
      - *Hylobius radicis*, 99
      - *Hylobius warreni*, 99
  - Seedlings, on roots or stems
    - Weevils
      - *Hylobius congener*, 99
      - *Hylobius pales*, 99
      - *Otiorhynchus ovatus*, 95
    - White grubs
      - *Phyllophaga*, 97
      - *Phyllophaga anxia*, 115
      - *Phyllophaga drakii*, 115
      - *Phyllophaga nitida*, 115

Pinus resinosa continued
      - *Phyllophaga rugosa*, 115
  - Trunk or large branches, in wood
    - Borers, roundheaded
      - *Monochamus scutellatus*, 87
    - Moths, pitch
      - *Dioryctria abietivorella*, 9, 85
    - Moths, pitch nodule
      - *Petrova metallica*, 69
  - Trunk or large branches, under bark
    - Beetles, bark
      - *Dendroctonus valens*, 79
      - *Ips pini*, 81
    - Weevils
      - *Hylobius congener*, 99
      - *Pissodes approximatus*, 73
  - Twigs or small branches, in wood
    - Borers, moth
      - *Eucosma gloriola*, 59
  - Twigs or small branches, on bark
    - Scales
      - *Toumeyella parvicornus*, 71
    - Spittlebugs
      - *Aphrophora saratogensis*, 65
    - Weevils
      - *Hylobius pales*, 99
      - *Hylobius radicis*, 99
      - *Hylobius warreni*, 99
  - Twigs or small branches, under bark
    - Moths, pitch nodule
      - *Petrova metallica*, 69
    - Moths, twig
      - *Dioryctria abietivorella*, 9, 85

Pinus strobus Linnaeus (eastern white pine)
  - Buds or shoots, in
    - Budworms and their allies
      - *Choristoneura pinus*, 9, 13
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria reniculelloides*, 9, 29
  - Cones or seeds
    - Chalcids
      - *Megastigmus*, 7
      - *Megastigmus atedius atedius*, 7
    - Moths
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria reniculelloides*, 9, 29
  - Foliage, in
    - Miners; moths
      - *Argyrotaenia pinatubana*, 43
  - Foliage, on
    - Aphids, woolly
      - *Pineus pinifoliae*, 51
    - Beetles, longhorned
      - *Monochamus notatus*, 87
      - *Monochamus scutellatus*, 87
    - Budworms and their allies
      - *Choristoneura pinus*, 9, 13
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria reniculelloides*, 9, 29
    - Caterpillars
      - *Anomogyna elimata*, 17
      - *Anomogyna perquiritata*, 17
      - *Dasychira plagiata*, 19
      - *Eilema bicolor*, 19
      - *Elaphria versicolor*, 17
      - *Feralia jocosa*, 17
      - *Incisalia eryphon*, 21
      - *Incisalia niphon clarki*, 21
      - *Lapara bombycoides*, 21
      - *Lithophane innominata*, 137
      - *Orgyia antiqua*, 19, 127
      - *Orgyia leucostigma*, 19, 127
      - *Palthis angulalis*, 17
      - *Panthea acronyctoides*, 19
      - *Panthea furcilla*, 19
      - *Panthea pallescens*, 19
      - *Tolype lari[illegible]s*, 19
      - *Zale duplicata*, 17
    - Leaftiers
      - *Argyrotaenia pinatubana*, 43
    - Loopers
      - *Anacamptodes vellivolata*, 25, 27
      - *Caripeta angustiorata*, 27
      - *Caripeta divisata*, 27
      - *Cladara limitaria*, 27
      - *Eufidonia discospilata*, 27
      - *Eufidonia notataria*, 27
      - *Eupithecia luteata*, 25
      - *Eupithecia palpata*, 25
      - *Hydriomena divisaria*, 25
      - *Hypagyrtis piniata*, 27
      - *Lambdina fiscellaria*, 27, 177
      - *Nepytia canosaria*, 23
      - *Pero morrisonaria*, 181
      - *Prochoerodes transversata*, 179
      - *Protoboarmia porcelaria indicataria*, 27
      - *Semiothisa bicolorata*, 23, 27
      - *Semiothisa oweni*, 23
      - *Semiothisa signaria dispuncta*, 23
    - Sawflies
      - *Diprion similis*, 35
      - *Neodiprion nanulus nanulus*, 35
      - *Neodiprion sertifer*, 35
      - *Neodiprion swainei*, 35
    - Sawflies, webspinning
      - *Acantholyda zappei*, 39
    - Tube makers
      - *Argyrotaenia pinatubana*, 43
  - Roots or basal stem, under bark
    - Weevils
      - *Hylobius congener*, 99
      - *Hylobius pales*, 99
      - *Hylobius radicis*, 99
  - Seedlings, on roots or stems
    - Weevils
      - *Hylobius congener*, 99
      - *Hylobius pales*, 99
      - *Otiorhynchus ovatus*, 95
  - Trunk or large branches, in wood
    - Ants, carpenter
      - *Camponotus pennsylvanicus*, 93
    - Borers, roundheaded
      - *Monochamus notatus*, 87
      - *Monochamus scutellatus*, 87
  - Trunk or large branches, under bark
    - Beetles, bark
      - *Dendroctonus valens*, 79
      - *Ips pini*, 81
    - Weevils
      - *Hylobius congener*, 99

Pinus strobus **continued**

- Moths, pitch
  - *Dioryctria abietivorella*, 9, 85
  - *Synanthedon pini*, 83
- Twigs or small branches, in wood
  - Borers; moths
    - *Eucosma gloriola*, 59
- Twigs or small branches, on bark
  - Aphids, woolly
    - *Pineus pinifoliae*, 51
  - Beetles, longhorned
    - *Monochamus notatus*, 87
    - *Monochamus scutellatus*, 87
  - Scales
    - *Toumeyella parvicornus*, 71
  - Spittlebugs
    - *Aphrophora cribrata*, 65
    - *Aphrophora saratogensis*, 65
  - Weevils
    - *Pissodes strobi*, 73
- Twigs or small branches, under bark
  - Moths, twig
    - *Dioryctria abietivorella*, 9, 85
  - Weevils, terminal
    - *Pissodes strobi*, 73

Pinus sylvestris **Linnaeus** (Scots pine)

- Buds or shoots, in
  - Budworms and their allies
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Zeiraphera improbana*, 29
  - Moths, tip
    - *Rhyacionia adana*, 57
    - *Rhyacionia buoliana*, 57
- Cones or seeds
  - Moths
    - *Dioryctria abietivorella*, 9, 85
- Foliage, in
  - Miners; moths
    - *Rhyacionia adana*, 57
    - *Rhyacionia buoliana*, 57
    - *Tetralopha robustella*, 29
- Foliage, on
  - Budworms and their allies
    - *Choristoneura pinus*, 9, 13
    - *Dioryctria abietivorella*, 9, 85
    - *Zeiraphera improbana*, 29
  - Caterpillars
    - *Anomogyna elimata*, 17
    - *Dasychira plagiata*, 19
    - *Elaphria versicolor*, 17
    - *Feralia jocosa*, 17
    - *Incisalia niphon clarki*, 21
    - *Lapara bombycoides*, 21
    - *Palthis angulalis*, 17
    - *Panthea acronyctoides*, 19
    - *Panthea furcilla*, 19
    - *Panthea pallescens*, 19
    - *Tolype laricis*, 19
    - *Zale duplicata*, 17
  - Loopers
    - *Anacamptodes vellivolata*, 25, 27
    - *Caripeta angustiorata*, 27
    - *Eufidonia notataria*, 27
    - *Eupithecia palpata*, 25
    - *Hypagyrtis piniata*, 27
    - *Nepytia canosaria*, 23
    - *Protoboarmia porcelaria indicataria*, 27
    - *Semiothisa bicolorata*, 23, 27
    - *Semiothisa oweni*, 23
    - *Semiothisa signaria dispuncta*, 23
  - Sawflies
    - *Diprion similis*, 35
    - *Neodiprion abbotii*, 35
    - *Neodiprion sertifer*, 35
    - *Neodiprion swainei*, 35
  - Webworms and their allies
    - *Tetralopha robustella*, 29
  - Weevils
    - *Otiorhynchus ovatus*, 95
- Roots or basal stem, under bark
  - Weevils
    - *Hylobius congener*, 99
    - *Hylobius pales*, 99
    - *Hylobius radicis*, 99
- Seedlings, on roots or stems
  - Weevils
    - *Hylobius congener*, 99
    - *Hylobius pales*, 99
    - *Otiorhynchus ovatus*, 95
- Trunk or large branches, under bark
  - Beetles, bark
    - *Dendroctonus valens*, 79
    - *Ips pini*, 81
  - Moths, pitch
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria zimmermani*, 85
  - Moths, pitch nodule
    - *Petrova albicapitana*, 69
  - Weevils
    - *Hylobius congener*, 99
    - *Pissodes approximatus*, 73
- Twigs or small branches, in wood
  - Borers; moths
    - *Eucosma gloriola*, 59
- Twigs or small branches, on bark
  - Scales
    - *Toumeyella parvicornus*, 71
  - Spittlebugs
    - *Aphrophora cribrata*, 65
  - Weevils
    - *Hylobius radicis*, 99
- Twigs or small branches, under bark
  - Moths, pitch nodule
    - *Petrova albicapitana*, 69
  - Moths, twig
    - *Dioryctria abietivorella*, 9, 85

Plum (see *Prunus*)

Poplar (see *Populus*)

Populus (poplar)

- Buds or shoots, in
  - Borers, twig
    - *Gypsonoma haimbachiana*, 221
    - *Janus abbreviatus*, 221
  - Budworms and their allies
    - *Archips argyrospila*, 165
    - *Choristoneura conflictana*, 163
  - Miners; moths
    - *Malacosoma disstria*, 147, 229
- Buds or shoots, on
  - Gall formers; aphids
    - *Mordwilkoja vagabunda*, 209

Populus continued
- Gall formers; mites
  - *Aceria parapopuli*, 209
  - *Aceria* nr. *dispar*, 209
- Weevils
  - *Cryptorhynchus lapathi*, 221
- Foliage, in
  - Miners; beetles
    - *Zeugophora abnormis*, 205
    - *Zeugophora scutellaris*, 205
  - Miners; moths
    - *Gypsonoma haimbachiana*, 221
    - *Phyllocnistis populiella*, 203
    - *Phyllonorycter* nr. *salicifoliella*, 203
    - *Phyllonorycter* nr. *nipigon*, 203
  - Miners; sawflies
    - *Messa leucostoma*, 205
- Foliage, on
  - Aphids
    - *Asiphum* poss. *pseudobrysum*, 159
    - *Chaitophorus populicola*, 107
  - Beetles, flea
    - *Altica populi*, 113
  - Beetles, leaf
    - *Chrysomela crotchi*, 111
    - *Chrysomela knabi*, 111
    - *Chrysomela scripta*, 111
    - *Chrysomela semota*, 111
    - *Phratora frosti remissa*, 113
    - *Tricholochmaea decora*, 109
  - Beetles, scarab
    - *Cotalpa lanigera*, 115
  - Borers, roundheaded
    - *Oberea schaumi*, 223
    - *Saperda calcarata*, 225, 233
  - Bugs, plant
    - *Lygus lineolaris*, 119
  - Caterpillars
    - *Acronicta lanceolaria*, 19
    - *Acronicta leporina*, 125
    - *Acronicta lepusculina*, 125
    - *Antheraea polyphemus*, 123
    - *Apantesis virgo*, 129
    - *Automeris io*, 123
    - *Basilarchia arthemis*, 121
    - *Dasychira vagans*, 127
    - *Egira dolosa*, 145
    - *Eupsilia tristigmata*, 145
    - *Gluphisia septentrionis*, 135
    - *Haploa confusa*, 129
    - *Ipimorpha pleonectusa*, 137
    - *Lophocampa maculata*, 127
    - *Nymphalis antiopa*, 121
    - *Nymphalis vau-album j-album*, 121
    - *Orthosia hibisci*, 137
    - *Pachysphinx modesta*, 141
    - *Pheosia rimosa*, 131
    - *Phyllodesma americana*, 129
    - *Pterourus glaucus canadensis*, 121
    - *Raphia frater*, 145
    - *Schizura concinna*, 131
    - *Schizura leptinoides*, 131
    - *Smerinthus cerisyi*, 141
    - *Smerinthus jamaicensis*, 141
    - *Spilosoma dubia*, 129
    - *Tolype velleda*, 129
  - Caterpillars, tent
    - *Malacosoma disstria*, 147, 229
  - Gall formers; aphids
    - *Asiphum* poss. *pseudobrysum*, 159
    - *Pemphigus*, 157
    - *Pemphigus bursarius*, 157
    - *Pemphigus populitransversus*, 157
  - Leaf rollers
    - *Anacampsis niveopulvella*, 167
    - *Apotomis capreana*, 167
    - *Archips argyrospila*, 165
    - *Choristoneura conflictana*, 163
    - *Choristoneura rosaceana*, 169
    - *Clepsis persicana*, 169
    - *Epinotia solandriana*, 167
    - *Erynnis icelus*, 143
    - *Orthotaenia undulana*, 169
    - *Pseudexentera oregonana*, 167
    - *Pseudosciaphila duplex*, 167
  - Leaf skeletonizers
    - *Schizura concinna*, 131
  - Leafhoppers
    - *Idiocerus lachrymalis*, 161
  - Leaftiers
    - *Clostera albosigma*, 131
    - *Clostera apicalis*, 131
    - *Enargia decolor*, 167
    - *Psilocorsis reflexella*, 171
  - Loopers
    - *Biston betularia cognataria*, 181
    - *Cabera erythemaria*, 185
    - *Cabera variolaria*, 185
    - *Campaea perlata*, 177
    - *Ectropis crepuscularia*, 27, 177
    - *Ennomos magnaria*, 177
    - *Ennomos subsignaria*, 177
    - *Erannis tiliaria*, 177
    - *Eutrapela clemataria*, 179
    - *Hydriomena furcata*, 185
    - *Hydria undulata*, 183
    - *Itame exauspicata*, 181
    - *Itame loricaria julia*, 181
    - *Lomographa semiclarata*, 179
    - *Lycia rachelae*, 181
    - *Melanolophia canadaria*, 185
    - *Melanolophia signataria*, 185
    - *Metanema inatomaria*, 177
    - *Metarranthis duaria*, 183
    - *Nacophora quernaria*, 181
    - *Pero morrisonaria*, 181
    - *Phigalia titea*, 179
    - *Probole amicaria*, 179
    - *Prochoerodes transversata*, 179
    - *Protitame virginalis*, 177
    - *Protoboarmia porcelaria indicataria*, 23, 27
    - *Semiothisa ulsterata*, 181
    - *Sicya macularia*, 181
    - *Synaxis jubararia*, 183
  - Sawflies
    - *Cimbex americana*, 191
    - *Fallocampus albostigmus*, 193
    - *Fallocampus americanus*, 193
    - *Messa leucostoma*, 205
    - *Nematus hudsoniimagnus*, 189
    - *Nematus limbatus*, 189
    - *Nematus salicisodoratus*, 189

- ***Populus*** **continued**
      - *Nematus ventralis*, 189
      - *Rhogogaster californica*, 191
      - *Trichiocampus gregarius*, 195
      - *Trichiocampus simplicornis*, 195
      - *Trichiocampus viminalis*, 195
      - *Trichiosoma triangulum*, 191
    - Sawflies, leaffolding
      - *Phyllocolpa* nr. *agama*, 155
    - Scales
      - *Parthenolecanium corni*, 71, 215
    - Walkingsticks
      - *Diapheromera femorata*, 187
    - Webworms and their allies
      - *Hyphantria cunea*, 151
      - *Tetralopha aplastella*, 169
  - Roots, on
    - Aphids
      - *Chaitophorus populicola*, 107
  - Roots or basal stem, in wood
    - Borers, flatheaded
      - *Chrysobothris femorata*, 225
      - *Poecilonota cyanipes*, 223
    - Borers, roundheaded
      - *Saperda calcarata*, 225, 233
    - Moths, clearwing
      - *Paranthrene tabaniformis*, 235
      - *Sesia tibialis*, 235
  - Roots or basal stem, under bark
    - Borers, flatheaded
      - *Chrysobothris femorata*, 225
      - *Poecilonota cyanipes*, 223
    - Borers, roundheaded
      - *Saperda calcarata*, 225, 233
    - Moths, clearwing
      - *Sesia tibialis*, 235
  - Trunk or large branches, in wood
    - Ants, carpenter
      - *Camponotus noveboracensis*, 93
      - *Camponotus pennsylvanicus*, 93
    - Borers, flatheaded
      - *Chrysobothris femorata*, 225
      - *Poecilonota cyanipes*, 223
    - Borers, roundheaded
      - *Oberea schaumi*, 223
      - *Saperda calcarata*, 225, 233
      - *Saperda concolor*, 223
      - *Trachysida mutabilis*, 231
      - *Trigonarthris proxima*, 231
    - Carpenterworms
      - *Acossus centerensis*, 237
      - *Acossus populi*, 237
      - *Prionoxystus robiniae*, 237
    - Moths, clearwing
      - *Paranthrene tabaniformis*, 235
      - *Sesia tibialis*, 235
    - Weevils
      - *Cryptorhynchus lapathi*, 221
  - Trunk or large branches, on bark
    - Scales
      - *Quadraspidiotus perniciosus*, 215
  - Trunk or large branches, under bark
    - Borers, flatheaded
      - *Agrilus granulatus*, 229
      - *Agrilus liragus*, 229
      - *Chrysobothris femorata*, 225
      - *Poecilonota cyanipes*, 223
    - Weevils
      - *Cryptorhynchus lapathi*, 221
  - Twigs or small branches, in wood
    - Borers; moths
      - *Gypsonoma haimbachiana*, 221
    - Borers, roundheaded
      - *Oberea schaumi*, 223
    - Borers; sawflies
      - *Janus abbreviatus*, 221
    - Gall formers; beetles
      - *Saperda concolor*, 223
      - *Saperda populnea moesta*, 223, 235
    - Weevils
      - *Cryptorhynchus lapathi*, 221
  - Twigs or small branches, on bark
    - Aphids
      - *Chaitophorus populicola*, 107
    - Bugs, plant
      - *Lygus lineolaris*, 119
    - Scales
      - *Chionaspis furfura*, 215
      - *Parthenolecanium corni*, 215
      - *Lepidosaphes ulmi*, 215
      - *Quadraspidiotus perniciosus*, 215
    - Treehoppers
      - *Ceresa bisonia*, 161
  - Twigs or small branches, under bark
    - Borers; moths
      - *Gypsonoma haimbachiana*, 221
    - Borers; sawflies
      - *Janus abbreviatus*, 221

- ***Populus angustifolia*** **James** (narrowleaf cottonwood)
  - Foliage, on
    - Gall formers; aphids
      - *Pemphigus betae*, 157

- ***Populus balsamifera*** **Linnaeus** (balsam poplar)
  - Buds or shoots, in
    - Borers; moths
      - *Gypsonoma haimbachiana*, 221
    - Budworms and their allies
      - *Archips argyrospila*, 165
      - *Choristoneura conflictana*, 163
    - Miners; moths
      - *Malacosoma disstria*, 147, 229
      - *Operophtera bruceata*, 173
  - Buds or shoots, on
    - Gall formers; aphids
      - *Mordwilkoja vagabunda*, 209
    - Gall formers; mites
      - *Aceria parapopuli*, 209
  - Foliage, in
    - Miners; beetles
      - *Zeugophora abnormis*, 205
    - Miners; moths
      - *Gypsonoma haimbachiana*, 221
      - *Phyllonorycter* nr. *nipigon*, 203
    - Miners; sawflies
      - *Messa leucostoma*, 205
  - Foliage, on
    - Aphids
      - *Parathecabius populimonilis*, 155
    - Beetles, flea
      - *Altica populi*, 113

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- Beetles, leaf
    - *Chrysomela falsa*, 111
    - *Chrysomela semota*, 111
- Bugs, lace
    - *Corythucha mollicula*, 117
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    - *Epinotia criddleana*, 167
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    - *Erynnis icelus*, 143
    - *Orthotaenia undulana*, 169
    - *Pandemis limitata*, 167
    - *Pseudosciaphila duplex*, 167
- Leaftiers
    - *Clostera albosigma*, 131
    - *Clostera apicalis*, 131
    - *Enargia decolor*, 167
    - *Nycteola cinereana*, 169
    - *Psilocorsis reflexella*, 171
    - *Rheumaptera hastata*, 177
- Loopers
    - *Alsophila pometaria*, 175
    - *Anavitrinelia pampinaria*, 179
    - *Biston betularia cognataria*, 181
    - *Cabera variolaria*, 185
    - *Campaea perlata*, 177
    - *Ennomos magnaria*, 177
    - *Erannis tiliaria*, 177
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    - *Rhogogaster californica*, 191
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- Borers, roundheaded
    - *Saperda calcarata*, 225, 233
- Moths, clearwing
    - *Sesia tibialis*, 235
- Moths, ghost
    - *Sthenopis argenteomaculatus*, 225
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Roots or basal stem, under bark
- Borers, roundheaded
    - *Saperda calcarata*, 225, 233
- Moths, clearwing
    - *Sesia tibialis*, 235

Trunk or large branches, in wood
- Borers, roundheaded
    - *Saperda calcarata*, 233
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    - *Prionoxystus robiniae*, 237
- Moths, clearwing
    - *Sesia tibialis*, 235

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- Borers, flatheaded
    - *Agrilus liragus*, 229

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  - Twigs or small branches, in wood
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      - *Gypsonoma haimbachiana*, 221
    - Borers, roundheaded
      - *Saperda populnea moesta*, 223
  - Twigs or small branches, on bark
    - Treehoppers
      - *Ceresa bisonia*, 161
    - Spittlebugs
      - *Lepyronia quadrangularis*, 161

- ***Populus deltoides* Bartram var. *occidentalis* Rhydberg** (plains cottonwood)
  - Buds or shoots, in
    - Miners; moths
      - *Malacosoma disstria*, 147, 229
  - Buds or shoots, on
    - Gall formers; aphids
      - *Mordwilkoja vagabunda*, 209
  - Foliage, in
    - Miners; beetles
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  - Foliage, on
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    - Caterpillars, tent
      - *Malacosoma disstria*, 147, 229
    - Leaf skeletonizers
      - *Datana ministra*, 135
  - Trunk or large branches, in wood
    - Carpenterworms
      - *Prionoxystus robiniae*, 237

- ***Populus grandidentata* Michaux** (largetooth aspen)
  - Buds or shoots, in
    - Budworms and their allies
      - *Archips argyrospila*, 165
      - *Choristoneura conflictana*, 163
  - Foliage, on
    - Caterpillars
      - *Acronicta lepusculina*, 125
      - *Amphipyra pyramidoides*, 145
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      - *Orthosia hibisci*, 137
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      - *Smerinthus jamaicensis*, 141
    - Caterpillars, tent
      - *Malacosoma americanum*, 149
      - *Malacosoma disstria*, 147, 229
    - Leaf rollers
      - *Anacampsis niveopulvella*, 167
      - *Archips argyrospila*, 165
      - *Choristoneura conflictana*, 163
      - *Epinotia solandriana*, 167
      - *Pseudosciaphila duplex*, 167
    - Leaf skeletonizers
      - *Datana ministra*, 135
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      - *Brachylomia populi*, 145
      - *Clostera albosigma*, 131
      - *Enargia decolor*, 167
      - *Psilocorsis reflexella*, 171
    - Loopers
      - *Alsophila pometaria*, 175
      - *Cabera variolaria*, 185
      - *Erannis tiliaria*, 177
      - *Itame loricaria julia*, 181
      - *Lobophora nivigerata*, 183
      - *Metanema inatomaria*, 177
      - *Phigalia titea*, 179
      - *Protitame virginalis*, 177
    - Webworms and their allies
      - *Meroptera pravella*, 169
      - *Tetralopha aplastella*, 169

- ***Populus tremuloides* Michaux** (trembling aspen)
  - Buds or shoots, in
    - Budworms and their allies
      - *Archips argyrospila*, 165
      - *Choristoneura conflictana*, 163
    - Miners; moths
      - *Malacosoma disstria*, 147, 229
      - *Operophtera bruceata*, 173
  - Buds or shoots, on
    - Gall formers; aphids
      - *Mordwilkoja vagabunda*, 209
    - Gall formers; mites
      - *Aceria* nr. *dispar*, 209
      - *Aceria parapopuli*, 209
  - Foliage, in
    - Miners; moths
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      - *Phyllonorycter* nr. *salicifoliella*, 203
  - Foliage, on
    - Beetles; borers
      - *Agrilus liragus*, 229
    - Beetles, leaf
      - *Chrysomela crotchi*, 111
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    - Caterpillars
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      - *Acronicta dactylina*, 125
      - *Acronicta grisea*, 125
      - *Acronicta innotata*, 125
      - *Acronicta leporina*, 125
      - *Acronicta lepusculina*, 125
      - *Acronicta quadrata*, 125
      - *Actias luna*, 123
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    - *Trichiosoma triangulum*, 191
  - Walkingsticks
    - *Diapheromera femorata*, 187
  - Webworms and their allies
    - *Archips cerasivorana*, 151
    - *Archips fervidana*, 151
    - *Hyphantria cunea*, 151
    - *Meroptera pravella*, 169
    - *Tetralopha aplastella*, 169
- Roots or basal stem, in wood
  - Borers, flatheaded
    - *Chrysobothris femorata*, 225
  - Borers, roundheaded
    - *Saperda calcarata*, 225, 233
  - Moths, clearwing
    - *Sesia tibialis*, 235
  - Moths, ghost
    - *Sthenopis quadriguttatus*, 225
- Roots, on bark
  - Cicadas
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- Roots or basal stem, under bark
  - Borers, flatheaded
    - *Chrysobothris femorata*, 225
  - Borers, roundheaded
    - *Saperda calcarata*, 225
  - Moths, clearwing
    - *Sesia tibialis*, 235
- Trunk or large branches, in wood
  - Ants, carpenter
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    - *Camponotus pennsylvanicus*, 93
  - Beetles, darkling
    - *Upis ceramboides*, 231
  - Borers, flatheaded
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  - Moths, clearwing
    - *Sesia tibialis*, 235
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  - Borers, flatheaded
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- Twigs or small branches, on bark
  - Aphids
    - *Chaitophorus populicola*, 107
  - Cicadas
    - *Tibicen pruinosa*, 161
  - Scales
    - *Chionaspis furfura*, 215
    - *Lepidosaphes ulmi*, 215

Populus trichocarpa **Torrey & Gray** (black cottonwood)
- Buds or shoots, in
  - Budworms and their allies
    - *Choristoneura conflictana*, 163
- Foliage, on
  - Beetles, leaf
    - *Chrysomela semota*, 111
  - Caterpillars
    - *Acronicta lepusculina*, 125
    - *Haploa confusa*, 129
    - *Ipimorpha pleonectusa*, 137
    - *Nadata gibbosa*, 135
    - *Orthosia hibisci*, 137
    - *Pheosia rimosa*, 131
    - *Phyllodesma americana*, 129
    - *Raphia frater*, 145
    - *Schizura concinna*, 131
    - *Smerinthus jamaicensis*, 141
  - Caterpillars, tent
    - *Malacosoma californicum pluviale*, 149
  - Leaf rollers
    - *Anacampsis niveopulvella*, 167
    - *Choristoneura conflictana*, 163
    - *Epinotia solandriana*, 167
  - Leaf skeletonizers
    - *Schizura concinna*, 131
  - Leaftiers
    - *Clostera apicalis*, 131
    - *Nycteola cinereana*, 169
  - Loopers
    - *Hesperumia sulphuraria*, 183
    - *Lambdina fiscellaria*, 27, 177
    - *Probole amicaria*, 179
    - *Synaxis jubararia*, 183
  - Webworms and their allies
    - *Hyphantria cunea*, 151
    - *Tetralopha aplastella*, 169

Prunus (cherries and plums)
- Buds or shoots, in
  - Miners; moths
    - *Malacosoma disstria*, 147, 229
- Foliage, on
  - Bugs, plant
    - *Lygus lineolaris*, 119
  - Caterpillars
    - *Actias luna*, 123
    - *Arctia caja americana*, 129
    - *Datana ministra*, 135
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    - *Nadata gibbosa*, 135
    - *Pterourus glaucus canadensis*, 121
    - *Schizura concinna*, 131
  - Caterpillars, tent
    - *Malacosoma americanum*, 149

Prunus continued
    - *Malacosoma californicum lutescens*, 149
    - *Malacosoma californicum pluviale*, 149
    - *Malacosoma disstria*, 147, 229
  - Gall formers; mites
    - *Eriophyes* nr. *padi*, 153
  - Leaf rollers
    - *Archips purpurana*, 169
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    - *Pseudosciaphila duplex*, 167
  - Leaf skeletonizers
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    - *Datana ministra*, 135
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    - *Schizura concinna*, 131
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    - *Metarranthis duaria*, 183
    - *Paleacrita vernata*, 175
    - *Pero honestaria*, 181
    - *Plagodis phlogosaria approximaria*, 179
    - *Prochoerodes transverata*, 179
  - Sawflies
    - *Arge clavicornis*, 191
    - *Dimorphopteryx abnormis*, 195
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    - *Trichiosoma triangulum*, 191
  - Walkingsticks
    - *Diapheromera femorata*, 187
  - Webworms and their allies
    - *Archips cerasivorana*, 151
    - *Hyphantria cunea*, 151
- Trunk or large branches, in wood
  - Ants, carpenter
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- Trunk or large branches, on bark
  - Scales
    - *Chionaspis furfura*, 215
    - *Quadraspidiotus perniciosus*, 215
- Twigs or small branches, in black knot
  - Moths, clearwing
    - *Synanthedon pictipes*, 235
- Twigs or small branches, on bark
  - Mites
    - *Eriophyes* nr. *padi*, 153
  - Scales
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    - *Lepidosaphes ulmi*, 215
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Prunus nigra **Aiton** (Canada plum)
- Foliage, on
  - Caterpillars
    - *Acronicta quadrata*, 125
    - *Lophocampa maculata*, 127
    - *Sphinx chersis*, 141
  - Caterpillars, tent
    - *Malacosoma californicum lutescens*, 149
    - *Malacosoma californicum pluviale*, 149
  - Gall formers; mites
    - *Eriophyes* nr. *padi*, 153
  - Loopers
    - *Alsophila pometaria*, 175
    - *Erannis tiliaria*, 177
  - Webworms and their allies
    - *Archips cerasivorana*, 151
    - *Hyphantria cunea*, 151
- Twigs or small branches, on bark
  - Mites
    - *Eriophyes* nr. *padi*, 153

Prunus padus **Linnaeus var. *commutata* Dippel** (May Day tree)
- Foliage, on
  - Caterpillars
    - *Arctia caja americana*, 129

Prunus pennsylvanica **Carl von Linné** (pin cherry)
- Buds or shoots, in
  - Budworms and their allies
    - *Archips argyrospila*, 165
    - *Choristoneura conflictana*, 163
  - Miners; moths
    - *Malacosoma disstria*, 147, 229
- Foliage, on
  - Caterpillars
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    - *Acronicta grisea*, 125
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    - *Palthis angulalis*, 17
    - *Papestra cristifera*, 137
    - *Schizura concinna*, 131
    - *Sphinx chersis*, 141
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    - *Spilosoma virginica*, 127
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    - *Malacosoma californicum lutescens*, 149
    - *Malacosoma californicum pluviale*, 149
    - *Malacosoma disstria*, 147, 229
  - Leaf rollers
    - *Archips argyrospila*, 165
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    - *Choristoneura conflictana*, 163
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- ***Prunus pensylvanica* continued**
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    - *Pero honestaria*, 181
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    - *Plagodis phlogosaria approximaria*, 179
    - *Probole amicaria*, 179
  - Webworms and their allies
    - *Archips cerasivorana*, 151
    - *Hyphantria cunea*, 151
  - Twigs or small branches, on bark
    - Treehoppers
      - *Ceresa diceros*, 161

- ***Prunus virginiana* Linnaeus** (choke cherry)
  - Buds or shoots, in
    - Budworms and their allies
      - *Archips argyrospila*, 165
      - *Choristoneura conflictana*, 163
    - Miners; moths
      - *Malacosoma disstria*, 147, 229
      - *Operophtera bruceata*, 173
  - Foliage, on
    - Bugs, plant
      - *Lygus lineolaris*, 119
    - Caterpillars
      - *Acronicta dactylina*, 125
      - *Acronicta grisea*, 125
      - *Acronicta hasta*, 125
      - *Acronicta quadrata*, 125
      - *Amphipyra pyramidoides*, 145
      - *Antheraea polyphemus*, 123
      - *Basilarchia arthemis*, 121
      - *Cucullia intermedia*, 137
      - *Datana ministra*, 135
      - *Eupsilia tristigmata*, 145
      - *Halysidota tessellaris*, 127
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      - *Heterocampa guttivitta*, 135
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      - *Lithophane amanda*, 137
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      - *Lophocampa maculata*, 127
      - *Oligocentria lignicolor*, 133
      - *Orgyia leucostigma*, 127
      - *Orthosia hibisci*, 137
      - *Schizura concinna*, 131
      - *Schizura unicornis*, 131
      - *Smerinthus jamaicensis*, 141
      - *Spilosoma dubia*, 129
    - Caterpillars, tent
      - *Malacosoma americanum*, 149
      - *Malacosoma californicum lutescens*, 149
      - *Malacosoma californicum pluviale*, 149
      - *Malacosoma disstria*, 147, 229
    - Gall formers; jumping plant lice
      - *Pachypsylla*, 155
    - Gall formers; mites
      - *Eriophyes emarginatae*, 153
    - Leaf rollers
      - *Archips argyrospila*, 165
      - *Archips purpurana*, 169
      - *Choristoneura conflictana*, 163
      - *Choristoneura rosaceana*, 169
      - *Epinotia solandriana*, 167
      - *Orthotaenia undulana*, 169
      - *Pandemis limitata*, 167
    - Leaf skeletonizers
      - *Caliroa cerasi*, 199
      - *Datana ministra*, 135
      - *Schizura concinna*, 131
    - Loopers
      - *Alsophila pometaria*, 175
      - *Anacamptodes ephyraria*, 183
      - *Cabera variolaria*, 185
      - *Ennomos magnaria*, 177
      - *Erannis tiliaria*, 177
      - *Eutrapela clemataria*, 179
      - *Hesperumia sulphuraria*, 183
      - *Hydriomena furcata*, 185
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      - *Lomographa semiclarata*, 179
      - *Lycia rachelae*, 181
      - *Melanolophia canadaria*, 185
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      - *Nemoria mimosaria*, 143
      - *Operophtera bruceata*, 173
      - *Paleacrita vernata*, 175
      - *Phigalia titea*, 179
      - *Probole amicaria*, 179
      - *Prochoerodes transversata*, 179
    - Sawflies
      - *Dimorphopteryx abnormis*, 195
    - Webworms and their allies
      - *Archips cerasivorana*, 151
      - *Archips fervidana*, 151
      - *Hyphantria cunea*, 151
      - *Tetralopha aplastella*, 169
  - Fruits or seeds
    - Maggots
      - *Contarinia virginianiae*, 105
    - Sawflies
      - *Hoplocampa lacteipennis*, 105
  - Twigs or small branches, on bark
    - Mites
      - *Eriophyes emarginatae*, 153
    - Treehoppers
      - *Telamona scalaris*, 161

- ***Pseudotsuga menziesii* (Mirbel) Franco** (Douglas-fir)
  - Buds or shoots, in
    - Budworms and their allies
      - *Acleris variana*, 15
      - *Choristoneura occidentalis*, 15
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria reniculelloides*, 9, 29
      - *Epinotia radicana*, 29
      - *Zeiraphera canadensis*, 29
      - *Zeiraphera improbana*, 29
  - Cones or seeds
    - Chalcids
      - *Megastigmus*, 7
    - Moths
      - *Barbara colfaxiana*, 9
      - *Dioryctria abietivorella*, 9, 85
      - *Dioryctria reniculelloides*, 9, 29
  - Foliage, in
    - Miners; moths
      - *Choristoneura occidentalis*, 15

***Pseudotsuga menziesii* continued**
- Foliage, on
  - Aphids, woolly
    - *Adelges cooleyi*, 11, 51
  - Beetles, longhorned
    - *Monochamus scutellatus*, 87
  - Budworms and their allies
    - *Acleris variana*, 15
    - *Choristoneura occidentalis*, 15
    - *Dioryctria abietivorella*, 9, 85
    - *Dioryctria reniculelloides*, 9, 29
    - *Epinotia radicana*, 29
    - *Zeiraphera canadensis*, 9
    - *Zeiraphera improbana*, 29
  - Caterpillars
    - *Anomogyna elimata*, 17
    - *Anomogyna perquiritata*, 17
    - *Dasychira grisefacta*, 19
    - *Dasychira plagiata*, 19
    - *Dasychira vagans*, 127
    - *Eilema bicolor*, 19
    - *Feralia jocosa*, 17
    - *Idia aemula*, 17
    - *Incisalia eryphon*, 21
    - *Lithophane innominata*, 137
    - *Melanchra pulverulenta*, 17
    - *Orgyia antiqua*, 19, 127
    - *Orthosia hibisci*, 137
    - *Palthis angulalis*, 17
    - *Panthea acronyctoides*, 17
    - *Papestra cristifera*, 137
    - *Syngrapha alias interalia*, 17
    - *Syngrapha rectangula*, 17
    - *Syngrapha viridisigma*, 17
  - Leaftiers
    - *Argyrotaenia occultana*, 29
    - *Argyrotaenia tabulana*, 43
  - Loopers
    - *Anagoga occiduaria*, 185
    - *Anavitrinelia pampinaria*, 179
    - *Campaea perlata*, 177
    - *Caripeta angustiorata*, 27
    - *Caripeta divisata*, 27
    - *Cladara limitaria*, 27
    - *Ectropis crepuscularia*, 27, 177
    - *Eupithecia annulata*, 25
    - *Eupithecia filmata*, 25
    - *Eupithecia luteata*, 25
    - *Eupithecia transcanadata*, 25
    - *Hesperumia sulphuraria*, 183
    - *Hydriomena divisaria*, 25
    - *Hypagyrtis piniata*, 27
    - *Lambdina fiscellaria*, 27, 177
    - *Metanema inatomaria*, 177
    - *Nematocampa limbata*, 21, 143
    - *Nepytia freemani*, 23
    - *Nepytia umbrosaria nigrovenaria*, 23
    - *Pero morrisonaria*, 181
    - *Protoboarmia porcelaria indicataria*, 23, 27
    - *Semiothisa signaria dispuncta*, 23
  - Mites
    - *Oligonychus ununguis*, 31
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    - *Neodiprion abietis*, 33, 35
    - *Neodiprion* nr. *scutellatus*, 35
  - Scales
    - *Chionaspis pinifoliae*, 41
  - Tube makers
    - *Argyrotaenia tabulana*, 43
- Seedlings, on roots or stems
  - Cutworms
    - *Nomophila nearctica*, 97
- Trunk or large branches, in wood
  - Ants, carpenter
    - *Camponotus*, 93
  - Borers, miscellaneous
    - *Serropalpus substriatus*, 89
  - Borers, roundheaded
    - *Monochamus scutellatus*, 87
    - *Semanotus litigiosus*, 89
  - Horntails
    - *Sirex cyaneus*, 91
    - *Urocerus albicornis*, 91
    - *Urocerus gigas flavicornis*, 91
    - *Xeris spectrum spectrum*, 91
- Trunk or large branches, under bark
  - Beetles, bark
    - *Dendroctonus pseudotsugae*, 79
    - *Dendroctonus valens*, 79
  - Borers, flatheaded
    - *Melanophila drummondi*, 89
  - Borers, roundheaded
    - *Monochamus scutellatus*, 87
    - *Semanotus litigiosus*, 89
  - Moths, pitch
    - *Dioryctria abietivorella*, 9, 85
    - *Synanthedon novaroensis*, 83
    - *Synanthedon sequoiae*, 83
- Twigs or small branches, on bark
  - Beetles, longhorned
    - *Monochamus scutellatus*, 87
  - Spittlebugs
    - *Aphrophora gelida*, 65
- Twigs or small branches, under bark
  - Moths, twig
    - *Dioryctria abietivorella*, 9, 85

Quercus (oak)
- Buds or shoots, in
  - Miners; moths
    - *Malacosoma disstria*, 147, 229
- Foliage, on
  - Beetles, scarab
    - *Cotalpa lanigera*, 115
    - *Dichelonyx subvittata*, 115
  - Bugs, lace
    - *Corythucha arcuata*, 117
  - Bugs, stink
    - *Banasa dimidiata*, 65, 119
  - Caterpillars
    - *Acronicta americana*, 125
    - *Actias luna*, 123
    - *Anisota virginiensis*, 133
    - *Antheraea polyphemus*, 123
    - *Automeris io*, 123
    - *Datana ministra*, 135
    - *Lithophane unimoda*, 137
    - *Lochmaeus manteo*, 133
    - *Lophocampa maculata*, 127
    - *Lymantria dispar*, 119

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        - *Nadata gibbosa*, 135
        - *Oligocentria lignicolor*, 133
        - *Orgyia antiqua*, 19, 127
        - *Orgyia leucostigma*, 19, 127
        - *Phyllodesma americana*, 129
        - *Schizura concinna*, 131
        - *Symmerista canicosta*, 133
        - *Tolype velleda*, 129
    - Caterpillars, tent
        - *Malacosoma americanum*, 149
        - *Malacosoma disstria*, 147, 229
    - Gall formers; wasps
        - *Andricus quercuspetiolicola*, 213
        - *Disholcaspis quercusmamma*, 213
        - *Neuroterus*, 155
    - Katydids
        - *Scudderia curvicauda*, 187
        - *Scudderia pistillata*, 187
    - Leaf rollers
        - *Antaeotricha schlaegeri*, 171
        - *Archips argyrospila*, 165
        - *Epinotia criddleana*, 167
        - *Erynnis juvenalis*, 143
        - *Pandemis limitata*, 167
    - Leaf skeletonizers
        - *Datana ministra*, 135
        - *Lochmaeus manteo*, 133
        - *Schizura concinna*, 131
    - Loopers
        - *Alsophila pometaria*, 175
        - *Besma quercivoraria*, 179
        - *Cyclophora pendulinaria*, 183
        - *Ectropis crepuscularia*, 27, 177
        - *Ennomos magnaria*, 177
        - *Ennomos subsignaria*, 177
        - *Erannis tiliaria*, 177
        - *Lambdina fiscellaria*, 27, 177
        - *Melanolophia canadaria*, 185
        - *Melanolophia signaria*, 185
        - *Nacophora quernaria*, 181
        - *Nematocampa limbata*, 21, 143
        - *Phigalia titea*, 179
        - *Plagodis alcoolaria*, 179
        - *Prochoerodes transversata*, 179
        - *Protoboarmia porcelaria indicataria*, 23, 27
    - Sawflies
        - *Periclista albicollis*, 195
        - *Pristiphora chlorea*, 197
    - Walkingsticks
        - *Diapheromera femorata*, 187
- Fruits or seeds
    - Weevils
        - *Curculio iowensis*, 103
- Trunk or large branches, in wood
    - Ants, carpenter
        - *Camponotus noveboracensis*, 93
        - *Camponotus pennsylvanicus*, 93
    - Borers, flatheaded
        - *Chrysobothris femorata*, 225
    - Borers, roundheaded
        - *Trachysida mutabilis*, 231
    - Carpenterworms
        - *Prionoxystus robiniae*, 237
    - Horntails
        - *Tremex columba*, 239
    - Woodwasps
        - *Xiphydria tibialis*, 239
- Trunk or large branches, under bark
    - Borers, flatheaded
        - *Chrysobothris femorata*, 225
- Twigs or small branches, on or in bark
    - Gall formers; wasps
        - *Disholcaspis spongiosa*, 213
    - Treehoppers
        - *Ceresa bisonia*, 161
        - *Ceresa diceros*, 161
        - *Telamona spreta*, 161

Quercus macrocarpa **Michaux** (bur oak)
- Buds or shoots, in
    - Miners; moths
        - *Malacosoma disstria*, 147, 229
- Foliage, in
    - Miners; moths
        - *Cameraria hamadryadella*, 205
        - *Cameraria macrocarpae*, 205
        - *Chionodes formosella*, 171
- Foliage, on
    - Bugs, lace
        - *Corythucha arcuata*, 117
    - Bugs, stink
        - *Banasa dimidiata*, 65, 119
    - Caterpillars
        - *Achatia distincta*, 137
        - *Actias luna*, 123
        - *Amphipyra pyramidoides*, 145
        - *Anisota virginiensis*, 133
        - *Antheraea polyphemus*, 123
        - *Catocala coccinata*, 139
        - *Cosmia calami*, 137
        - *Cucullia intermedia*, 137
        - *Datana ministra*, 135
        - *Erynnis juvenalis*, 143
        - *Halysidota tessellaris*, 127
        - *Lithophane amanda*, 137
        - *Lochmaeus manteo*, 133
        - *Meganola minuscula*, 129
        - *Nadata gibbosa*, 135
        - *Oligocentria lignicolor*, 133
        - *Orthosia hibisci*, 137
        - *Salebriaria tenebrosella*, 171
        - *Symmerista canicosta*, 133
        - *Tolype velleda*, 129
    - Caterpillars, tent
        - *Malacosoma disstria*, 147, 229
    - Gall formers; wasps
        - *Callirhytis* nr. *flavipes*, 211
        - *Neuroterus*, 155
    - Leaf rollers
        - *Antaeotricha schlaegeri*, 171
        - *Archips purpurana*, 169
        - *Chionodes formosella*, 171
        - *Choristoneura rosaceana*, 169
        - *Epinotia criddleana*, 167
        - *Filatima* nr. *persicaeella*, 171
        - *Pandemis limitata*, 167
    - Leaf skeletonizers
        - *Datana ministra*, 135
    - Leaftiers
        - *Chionodes formosella*, 171
        - *Psilocorsis reflexella*, 171

- ***Quercus macrocarpa* continued**
    - Loopers
      - *Alsophila pometaria*, 175
      - *Anacamptodes ephyraria*, 183
      - *Ennomos subsignaria*, 177
      - *Erannis tiliaria*, 177
      - *Hydriomena transfigurata manitoba*, 185
      - *Hypagyrtis unipunctata*, 179, 185
      - *Itame exauspicata*, 181
      - *Lambdina fervidaria athasaria*, 177
      - *Lambdina fiscellaria*, 27, 177
      - *Melanolophia signataria*, 185
      - *Nacophora quernaria*, 181
      - *Nemoria mimosaria*, 143
      - *Paleacrita vernata*, 175
      - *Phigalia titea*, 179
      - *Stenoporpia polygrammaria*, 183
      - *Synchlora aerata albolineata*, 143
    - Sawflies
      - *Caliroa poss. obsoleta*, 199
      - *Periclista albicollis*, 195
      - *Pristiphora chlorea*, 197
    - Skeletonizers
      - *Caliroa poss. obsoleta*, 199
    - Walkingsticks
      - *Diapheromera femorata*, 187
    - Webworms and their allies
      - *Archips cerasivorana*, 151
      - *Archips fervidana*, 151
  - Fruits or seeds
    - Weevils
      - *Curculio iowensis*, 103
  - Twigs or small branches, on or in bark
    - Gall formers; wasps
      - *Andricus quercuspetiolicola*, 213
      - *Callirhytis nr. flavipes*, 211
      - *Disholcaspis quercusmamma*, 213
      - *Disholcaspis spongiosa*, 213
    - Treehoppers
      - *Ceresa bisonia*, 161
      - *Ceresa diceros*, 161
      - *Cyrtolobus pallidifrontis*, 161
      - *Cyrtolobus tuberosus*, 161
      - *Telamona spreta*, 161

- ***Rosa*** (rose)
  - Buds or shoots, in
    - Budworms and their allies
      - *Choristoneura conflictana*, 163
  - Foliage, on
    - Beetles, scarab
      - *Phyllophaga anxia*, 115
      - *Phyllophaga drakii*, 115
      - *Phyllophaga nitida*, 115
      - *Phyllophaga rugosa*, 115
    - Caterpillars
      - *Eupsilia tristigmata*, 145
      - *Lithophane amanda*, 137
    - Caterpillars, tent
      - *Malacosoma californicum lutescens*, 149
      - *Malacosoma californicum pluviale*, 149
    - Leaf rollers
      - *Choristoneura conflictana*, 163
    - Loopers
      - *Erannis tiliaria*, 177
      - *Hesperumia sulphuraria*, 183
      - *Hypagyrtis unipunctata*, 179, 185
      - *Metarranthis duaria*, 183
    - Webworms and their allies
      - *Archips cerasivorana*, 151
- Rose (see Rosa)

- ***Salix*** (willow)
  - Buds or shoots, in
    - Budworms and their allies
      - *Archips argyrospila*, 165
      - *Choristoneura conflictana*, 163
    - Gall formers; midges
      - *Mayetiola rigidae*, 213
      - *Oligotrophus salicifolius*, 213
      - *Rhabdophaga salicisbatatas*, 213
      - *Rhabdophaga salicisbrassicoides*, 213
      - *Rhabdophaga strobiloides*, 213
    - Miners; moths
      - *Malacosoma disstria*, 147, 229
      - *Operophtera bruceata*, 173
    - Sawflies
      - *Euura atra*, 217
      - *Janus abbreviatus*, 221
  - Buds or shoots, on
    - Weevils
      - *Cryptorhynchus lapathi*, 221
  - Foliage, in
    - Miners; moths
      - *Micrurapteryx salicifoliella*, 207
  - Foliage, on
    - Beetles, leaf
      - *Calligrapha multipunctata multipunctata*, 111
      - *Calligrapha verrucosa*, 111
      - *Chrysomela falsa*, 111
      - *Chrysomela knabi*, 111
      - *Chrysomela scripta*, 111
      - *Chrysomela semota*, 111
      - *Disonycha alternata*, 111
      - *Pachybrachis bivittatus*, 111
      - *Phratora frosti remissa*, 113
      - *Tricholochmaea decora*, 109
    - Beetles, flea
      - *Altica bimarginata*, 113
    - Beetles, scarab
      - *Cotalpa lanigera*, 115
      - *Phyllophaga anxia*, 115
      - *Phyllophaga drakii*, 115
      - *Phyllophaga nitida*, 115
      - *Phyllophaga rugosa*, 115
    - Borers, roundheaded
      - *Oberea schaumi*, 223
      - *Saperda calcarata*, 225, 233
    - Bugs, lace
      - *Corythucha mollicula*, 117
      - *Corythucha pallipes*, 117
    - Bugs, plant
      - *Lygus lineolaris*, 119
    - Bugs, stink
      - *Chlorochroa persimilis*, 65, 119
      - *Elasmucha lateralis*, 119
    - Caterpillars
      - *Acronicta americana*, 125
      - *Acronicta dactylina*, 125
      - *Acronicta grisea*, 125
      - *Acronicta innotata*, 125
      - *Acronicta leporina*, 125

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    Acronicta quadrata, 125
    Actias luna, 123
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    Anisota virginiensis, 133
    Antheraea polyphemus, 123
    Automeris io, 123
    Basilarchia arthemis, 121
    Catocala relicta, 139
    Cucullia intermedia, 137
    Dasychira plagiata, 19
    Dasychira vagans, 127
    Datana ministra, 135
    Egira dolosa, 145
    Erynnis icelus, 143
    Eupsilia tristigmata, 145
    Furcula modesta, 131
    Furcula occidentalis, 131
    Halysidota tessellaris, 127
    Haploa confusa, 129
    Heterocampa guttivitta, 135
    Homoglaea hircina, 145
    Hyalophora cecropia, 123
    Hyalophora gloveri nokomis, 123
    Hyles gallii, 141
    Ipimorpha pleonectusa, 137
    Lithophane amanda, 137
    Lithophane innominata, 137
    Lithophane thaxteri, 17
    Lithophane unimoda, 137
    Lophocampa maculata, 127
    Lymantria dispar, 127
    Melanchra pulverulenta, 17
    Nadata gibbosa, 135
    Notodonta scitipennis, 131
    Notodonta simplaria, 131
    Nymphalis antiopa, 121
    Nymphalis vau-album j-album, 121
    Oligocentria semirufescens, 133
    Orgyia antiqua, 19, 127
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    Orthosia hibisci, 137
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    Palthis angulalis, 17
    Papestra cristifera, 137
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    Spilosoma virginica, 127
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    Malacosoma californicum lutescens, 149
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    Malacosoma disstria, 147, 229
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    Oecanthus nigricornis, 187
  Gall formers; sawflies
    Pontania, 155
    Pontania proxima, 155
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    Agonopterix argillacea, 169
    Anacampsis niveopulvella, 167
    Apotomis capreana, 167
    Archips argyrospila, 165
    Archips purpurana, 169
    Choreutis diana, 169
    Choristoneura conflictana, 163
    Choristoneura rosaceana, 169
    Clepsis persicana, 169
    Epinotia criddleana, 167
    Epinotia solandriana, 167
    Erynnis icelus, 143
    Nephopterix basilaris, 171
    Orthotaenia undulana, 169
    Pandemis limitata, 167
    Pseudosciaphila duplex, 167
    Ypsolopha senex, 167
  Leaf skeletonizers
    Datana ministra, 135
    Schizura concinna, 131
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    Enargia decolor, 167
    Nycteola frigidana, 169
    Psilocorsis reflexella, 171
    Rheumaptera hastata, 177
  Loopers
    Aethalura intertexta, 185
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    Trichiocampus viminalis, 195
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  Scales
    Parthenolecanium corni, 71, 215
  Webworms and their allies
    Archips cerasivorana, 151
    Hyphantria cunea, 151
    Meroptera pravella, 169
    Tetralopha aplastella, 169
 Roots, on bark
  Aphids
    Chaitophorus populicola, 107
 Roots or basal stem, in wood
  Borers, roundheaded
    Saperda calcarata, 225, 233
  Moths, clearwing
    Paranthrene tabaniformis, 235
    Sesia tibialis, 235
  Moths, ghost
    Sthenopis quadriguttatus, 225
 Roots or basal stem, under bark
  Borers, roundheaded
    Saperda calcarata, 225, 233
  Moths, clearwing
    Sesia tibialis, 235
 Trunk or large branches, in wood
  Ants, carpenter
    Camponotus pennsylvanicus, 93
  Borers, flatheaded
    Agrilus criddlei, 223
    Chrysobothris femorata, 225
    Poecilonota cyanipes, 223
  Borers, roundheaded
    Saperda calcarata, 225, 233
    Saperda concolor, 223
  Carpenterworms
    Prionoxystus robiniae, 237
  Moths, clearwing
    Paranthrene tabaniformis, 235
    Sesia tibialis, 235
    Synanthedon albicornis, 235
  Weevils
    Cryptorhynchus lapathi, 221
 Trunk or large branches, on bark
  Scales
    Quadraspidiotus perniciosus, 215
 Trunk or large branches, under bark
  Borers, flatheaded
    Agrilus criddlei, 223
    Chrysobothris femorata, 225
    Poecilonota cyanipes, 223
  Weevils
    Cryptorhynchus lapathi, 221
 Twigs or small branches, in wood
  Borers, flatheaded
    Agrilus criddlei, 223
    Poecilonota cyanipes, 223
  Borers, roundheaded
    Oberea schaumi, 223
  Borers; sawflies
    Euura atra, 217
    Janus abbreviatus, 221
  Crickets, tree
    Oecanthus nigricornis, 187
  Gall formers
    Agrilus criddlei, 223
    Saperda concolor, 223
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  Moths, clearwing
    Synanthedon albicornis, 235
  Weevils
    Cryptorhynchus lapathi, 221
 Twigs or small branches, on
  Aphids
    Chaitophorus populicola, 107
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  Scales
    Parthenolecanium corni, 71, 215
    Lepidosaphes ulmi, 215
    Quadraspidiotus perniciosus, 215
  Spittlebugs
    Lepyronia quadrangularis, 161

***Salix* continued**
  - Treehoppers
    - *Ceresa bisonia*, 161
- Twigs or small branches, under bark
  - Borers; sawflies
    - *Janus abbreviatus*, 221
  - Weevils
    - *Cryptorhynchus lapathi*, 221

***Salix bebbiana* Sargent** (Bebb or beaked willow)
- Trunk or large branches, in wood
  - Borers, flatheaded
    - *Agrilus criddlei*, 223
- Trunk or large branches, under bark
  - Borers, flatheaded
    - *Agrilus criddlei*, 223
- Twigs or small branches, in wood
  - Borers, flatheaded
    - *Agrilus criddlei*, 223
  - Gall formers; beetles
    - *Agrilus criddlei*, 223

***Salix interior* Rowlee** (sandbar willow)
- Foliage, on
  - Gall formers; sawflies
    - *Pontania*, 155

Sambucus (elder)
- Foliage, on
  - Crickets, tree
    - *Oecanthus nigricornis*, 187
  - Leaf rollers
    - *Phlyctaenia coronata tertialis*, 171
  - Loopers
    - *Anavitrinelia pampinaria*, 179
  - Webworms and their allies
    - *Hyphantria cunea*, 151
- Twigs or small branches, in or on
  - Borers; moths
    - *Phlyctaenia coronata tertialis*, 171
  - Crickets, tree
    - *Oecanthus nigricornis*, 187
  - Treehoppers
    - *Ceresa diceros*, 161

Saskatoon (see *Amelanchier*)

Serviceberry (see *Amelanchier*)

Sheperdia (buffaloberry)
- Foliage, on
  - Caterpillars
    - *Hyalophora gloveri nokomis*, 21, 123
    - *Papestra cristifera*, 137
    - *Synedoida hudsonica*, 139
  - Loopers
    - *Anavitrinelia pampinaria*, 179
    - *Biston betularia cognataria*, 181
    - *Campaea perlata*, 177
    - *Lycia rachelae*, 181
    - *Pero honestaria*, 181
    - *Pero morrisonaria*, 181
    - *Prochoerodes transversata*, 179
    - *Protoboarmia porcelaria indicataria*, 23, 27

***Shepherdia canadensis* (Linnaeus) Nuttall** (Canada buffaloberry)
- Foliage, on
  - Loopers
    - *Pero honestaria*, 181

Silverberry (see *Elaeagnus*)

Snowberry (see *Symphoricarpos*)

Sorbus (mountain-ash)
- Buds or shoots, in
  - Budworms and their allies
    - *Choristoneura conflictana*, 163
- Foliage, on
  - Bugs, lace
    - *Corythucha pallipes*, 117
  - Caterpillars
    - *Datana ministra*, 135
  - Leaf rollers
    - *Choristoneura conflictana*, 163
  - Loopers
    - *Lomographa semiclarata*, 179
    - *Nematocampa limbata*, 21, 143
    - *Nemoria mimosaria*, 143
  - Sawflies
    - *Caliroa cerasi*, 199
    - *Priophorus pallipes*, 193
    - *Pristiphora geniculata*, 197
  - Skeletonizers
    - *Caliroa cerasi*, 199
- Roots, on bark
  - Aphids, woolly
    - *Eriosoma lanigerum*, 159
- Roots or basal stem, in wood
  - Borers, roundheaded
    - *Saperda candida*, 225
- Roots or basal stem, under bark
  - Borers, roundheaded
    - *Saperda candida*, 225
- Trunk or large branches, in wood
  - Borers, roundheaded
    - *Saperda candida*, 225
  - Moths, clearwing
    - *Podosesia syringae*, 235
- Trunk or large branches, on bark
  - Aphids, woolly
    - *Eriosoma lanigerum*, 159
- Trunk or large branches, under bark
  - Borers, roundheaded
    - *Saperda candida*, 225
- Twigs or small branches, on bark
  - Aphids, woolly
    - *Eriosoma lanigerum*, 159
  - Scales
    - *Chionaspis furfura*, 215
    - *Quadraspidiotus perniciosus*, 215

Spruce (see *Picea*)

***Symphoricarpos occidentalis* Hooker** (western snowberry)
- Foliage, on
  - Beetles, blister
    - *Lytta sphaericollis*, 115
  - Caterpillars
    - *Apantesis virgo*, 129

Syringa (lilac)
- Foliage, in
  - Miners; moths
    - *Gracillaria syringella*, 205
- Foliage, on
  - Caterpillars
    - *Arctia caja americana*, 129
    - *Hyalophora cecropia*, 123

***Syringa* continued**
      - *Pterourus glaucus canadensis*, 121
    - Leaf rollers
      - *Gracillaria syringella*, 205
  - Roots or basal stem, in wood
    - Moths, clearwing
      - *Podosesia syringae*, 235
  - Trunk or large branches, in wood
    - Moths, clearwing
      - *Podosesia syringae*, 235
  - Twigs or small branches, on bark
    - Scales
      - *Lepidosaphes ulmi*, 215

Tamarack (see *Larix*)

Thuja (arbor-vitae)
  - Buds or shoots, in
    - Budworms and their allies
      - *Dioryctria reniculelloides*, 9, 29
  - Cones or seeds
    - Moths
      - *Dioryctria reniculelloides*, 9, 29
  - Foliage, on
    - Budworms and their allies
      - *Dioryctria reniculelloides*, 9, 29
    - Bugs, stink
      - *Banasa dimidiata*, 65
      - *Chlorochroa persimilis*, 65
    - Loopers
      - *Caripeta divisata*, 27
      - *Ectropis crepuscularia*, 27, 177
      - *Eupithecia gibsonata*, 25
      - *Eupithecia transcanadata*, 25
      - *Nematocampa limbata*, 21, 143
    - Mites
      - *Oligonychus ununguis*, 31
    - Sawflies
      - *Monoctenus melliceps*, 39
    - Weevils
      - *Otiorhynchus ovatus*, 95
      - *Otiorhynchus sulcatus*, 95
  - Seedlings, on roots or stems
    - Weevils
      - *Otiorhynchus ovatus*, 95
      - *Otiorhynchus sulcatus*, 95
  - Trunk or large branches, in wood
    - Ants, carpenter
      - *Camponotus herculeanus*, 93
    - Borers, roundheaded
      - *Semanotus ligneus ligneus*, 89
  - Trunk or large branches, under bark
    - Borers, roundheaded
      - *Semanotus ligneus ligneus*, 89
  - Twigs or small branches, on bark
    - Weevils
      - *Otiorhynchus ovatus*, 95
      - *Otiorhynchus sulcatus*, 95

***Thuja occidentalis* Linnaeus** (eastern white cedar)
  - Foliage, in
    - Miners; moths
      - *Argyresthia aureoargentella*, 61
      - *Argyresthia freyella*, 61
      - *Argyresthia thuiella*, 61
      - *Coleotechnites thujaella*, 61
  - Foliage, on
    - Caterpillars
      - *Anomogyna elimata*, 17
      - *Anomogyna perquiritata*, 17
      - *Elaphria versicolor*, 17
      - *Feralia jocosa*, 17
      - *Orgyia antiqua*, 19, 127
      - *Orthosia hibisci*, 137
      - *Palthis angulalis*, 17
    - Loopers
      - *Anavitrinelia pampinaria*, 179
      - *Caripeta divisata*, 27
      - *Cladara limitaria*, 27
      - *Ectropis crepuscularia*, 27, 177
      - *Eupithecia gibsonata*, 25
      - *Eupithecia luteata*, 25
      - *Hypagyrtis piniata*, 27
      - *Lambdina fiscellaria*, 27, 177
      - *Nepytia canosaria*, 23
      - *Prochoerodes transversata*, 179
      - *Protoboarmia porcelaria indicataria*, 23, 27
    - Scales
      - *Parthenolecanium cerasifex*, 71
      - *Parthenolecanium corni*, 71, 215
      - *Parthenolecanium fletcheri*, 71
    - Weevils
      - *Hylobius pales*, 99
      - *Otiorhynchus ovatus*, 95
      - *Otiorhynchus sulcatus*, 95
  - Roots, on bark
    - Weevils
      - *Hylobius pales*, 99
  - Roots or basal stem, under bark
    - Weevils
      - *Hylobius pales*, 99
  - Seedlings, on roots or stems
    - Weevils
      - *Hylobius pales*, 99
      - *Otiorhynchus ovatus*, 95
  - Trunk or large branches, in wood
    - Ants, carpenter
      - *Camponotus herculeanus*, 93
  - Trunk or large branches, under bark
    - Borers, flatheaded
      - *Melanophila acuminata*, 89
    - Borers, roundheaded
      - *Semanotus ligneus ligneus*, 89
  - Twigs or small branches, on bark
    - Aphids
      - *Cinara cupressi*, 63
    - Scales
      - *Parthenolecanium cerasifex*, 71
      - *Parthenolecanium corni*, 71, 215
      - *Parthenolecanium fletcheri*, 71

***Thuja plicata* Don** (western red cedar)
  - Buds or shoots, in
    - Budworms and their allies
      - *Acleris variana*, 15
  - Foliage, on
    - Budworms and their allies
      - *Acleris variana*, 15
      - *Epinotia radicana*, 29
    - Caterpillars
      - *Dasychira grisefacta*, 19

- ***Thuja plicata* continued**
      - *Eilema bicolor*, 19
      - *Idia aemula*, 17
      - *Incisalia eryphon*, 21
      - *Orgyia antiqua*, 127, 19
      - *Orthosia hibisci*, 137
      - *Palthis angulalis*, 17
      - *Syngrapha alias interalia*, 17
      - *Syngrapha viridisigma*, 17
    - Loopers
      - *Anavitrinelia pampinaria*, 179
      - *Campaea perlata*, 177
      - *Caripeta divisata*, 27
      - *Cladara limitaria*, 27
      - *Ectropis crepuscularia*, 27, 177
      - *Eupithecia annulata*, 25
      - *Eupithecia gibsonata*, 25
      - *Hypagyrtis piniata*, 27
      - *Lambdina fiscellaria*, 27, 177
      - *Nematocampa limbata*, 21, 143
      - *Nepytia umbrosaria nigrovenaria*, 23
      - *Pero morrisonaria*, 181
      - *Protoboarmia porcelaria indicataria*, 23, 27
      - *Semiothisa setonana*, 23
  - Trunk or large branches, in wood
    - Horntails
      - *Urocerus albicornis*, 91

- ***Tilia americana* Linnaeus** (basswood)
  - Buds or shoots, in
    - Budworms and their allies
      - *Archips argyrospila*, 165
    - Miners; moths
      - *Malacosoma disstria*, 147, 229
  - Foliage, on
    - Beetles, scarab
      - *Phyllophaga anxia*, 115
      - *Phyllophaga drakii*, 115
      - *Phyllophaga rugosa*, 115
    - Caterpillars
      - *Acronicta americana*, 125
      - *Actias luna*, 123
      - *Amphipyra pyramidoides*, 145
      - *Antheraea polyphemus*, 123
      - *Basilarchia arthemis*, 121
      - *Catocala cerogama*, 139
      - *Dasychira plagiata*, 19
      - *Datana ministra*, 135
      - *Eupsilia tristigmata*, 145
      - *Halysidota tessellaris*, 127
      - *Heterocampa guttivitta*, 135
      - *Homoglaea hircina*, 145
      - *Hyalophora cecropia*, 123
      - *Lithophane innominata*, 137
      - *Lochmaeus manteo*, 133
      - *Lomanaltes eductalis*, 139
      - *Lophocampa maculata*, 127
      - *Lymantria dispar*, 127
      - *Nymphalis antiopa*, 121
      - *Orgyia leucostigma*, 19, 127
      - *Orthosia hibisci*, 137
      - *Pterourus glaucus canadensis*, 121
      - *Schizura unicornis*, 131
      - *Symmerista canicosta*, 133
      - *Tolype velleda*, 129
    - Caterpillars, tent
      - *Malacosoma americanum*, 149
      - *Malacosoma disstria*, 147, 229
    - Leaf rollers
      - *Archips argyrospila*, 165
      - *Archips purpurana*, 169
      - *Choristoneura rosaceana*, 169
      - *Pandemis limitata*, 167
    - Leaf skeletonizers
      - *Datana ministra*, 135
      - *Lochmaeus manteo*, 133
    - Loopers
      - *Alsophila pometaria*, 175
      - *Campaea perlata*, 177
      - *Ennomos magnaria*, 177
      - *Ennomos subsignaria*, 177
      - *Erannis tiliaria*, 177
      - *Euchlaena marginaria*, 179
      - *Eutrapela clemataria*, 179
      - *Hypagyrtis unipunctata*, 179, 185
      - *Itame exauspicata*, 181
      - *Lambdina fiscellaria*, 27, 177
      - *Melanolophia canadaria*, 185
      - *Nacophora quernaria*, 181
      - *Nematocampa limbata*, 21, 143
      - *Nemoria mimosaria*, 143
      - *Paleacrita vernata*, 175
      - *Phigalia titea*, 179
      - *Plagodis alcoolaria*, 179
      - *Plagodis phlogosaria approximaria*, 179
      - *Probole alienaria*, 179
      - *Probole amicaria*, 179
      - *Prochoerodes transversata*, 179
    - Sawflies
      - *Cimbex americana*, 191
    - Walkingsticks
      - *Diapheromera femorata*, 187
    - Webworms and their allies
      - *Archips cerasivorana*, 151
      - *Hyphantria cunea*, 151
  - Trunk or large branches, in wood
    - Borers, roundheaded
      - *Trigonarthris proxima*, 67, 231
    - Woodwasps
      - *Xiphydria abdomalis*, 239
  - Twigs or small branches, on bark
    - Scales
      - *Lepidosaphes ulmi*, 215
      - *Parthenolecanium corni*, 71, 215
      - *Quadraspidiotus perniciosus*, 215

- ***Ulmus*** (elm)
  - Foliage, on
    - Aphids, woolly
      - *Eriosoma americanum*, 159
      - *Eriosoma lanigerum*, 159
    - Beetles, scarab
      - *Phyllophaga drakii*, 115
    - Bugs, lace
      - *Corythucha ulmi*, 117
    - Caterpillars
      - *Acronicta grisea*, 125
      - *Actias luna*, 123
      - *Antheraea polyphemus*, 123
      - *Automeris io*, 123
      - *Lithophane innominata*, 137
      - *Lochmaeus manteo*, 133
      - *Nymphalis antiopa*, 121
      - *Schizura concinna*, 131

Ulmus continued
- *Smerinthus jamaicensis*, 141
- *Symmerista canicosta*, 133
- *Tolype velleda*, 129
- Crickets, tree
  - *Oecanthus nigricornis*, 187
- Gall formers; aphids
  - *Eriosoma lanigerum*, 159
- Leaf skeletonizers
  - *Lochmaeus manteo*, 133
- Loopers
  - *Alsophila pometaria*, 175
  - *Anacamptodes ephyraria*, 183
  - *Anavitrinelia pampinaria*, 179
  - *Ennomos magnaria*, 177
  - *Ennomos subsignaria*, 177
  - *Erannis tiliaria*, 177
  - *Euchlaena marginaria*, 179
  - *Lambdina fiscellaria*, 27, 177
  - *Nematocampa limbata*, 21, 143
  - *Paleacrita vernata*, 175
- Sawflies
  - *Cimbex americana*, 191
- Scales
  - *Parthenolecanium corni*, 71, 215
  - *Quadraspidiotus perniciosus*, 215
- Walkingsticks
  - *Diapheromera femorata*, 187
- Trunk or large branches, in wood
  - Ants, carpenter
    - *Camponotus pennsylvanicus*, 93
  - Borers, flatheaded
    - *Chrysobothris femorata*, 225
  - Carpenterworms
    - *Prionoxystus robiniae*, 237
  - Horntails
    - *Tremex columba*, 239
  - Woodwasps
    - *Xiphydria tibialis*, 239
- Trunk or large branches, on bark
  - Scales
    - *Quadraspidiotus perniciosus*, 215
- Trunk or large branches, under bark
  - Beetles, bark
    - *Hylurgopinus rufipes*, 227
    - *Scolytus multistriatus*, 227
  - Borers, flatheaded
    - *Chrysobothris femorata*, 225
- Twigs or small branches, on bark
  - Beetles, bark
    - *Scolytus multistriatus*, 227
  - Scales
    - *Parthenolecanium corni*, 215
    - *Lepidosaphes ulmi*, 215
    - *Quadraspidiotus perniciosus*, 215
  - Treehoppers
    - *Ceresa bisonia*, 161
    - *Ceresa diceros*, 161

Ulmus americana Linnaeus (white elm)
- Buds or shoots, in
  - Budworms and their allies
    - *Archips argyrospila*, 165
  - Miners; moths
    - *Malacosoma disstria*, 147, 229
    - *Operophtera bruceata*, 173
- Foliage, on
  - Aphids, woolly
    - *Eriosoma americanum*, 159
    - *Eriosoma lanigerum*, 159
  - Beetles, flea
    - *Altica*, 113
  - Beetles, scarab
    - *Phyllophaga anxia*, 115
    - *Phyllophaga drakii*, 115
    - *Phyllophaga nitida*, 115
    - *Phyllophaga rugosa*, 115
  - Bugs, lace
    - *Corythucha ulmi*, 117
  - Caterpillars
    - *Acronicta americana*, 125
    - *Amphipyra pyramidoides*, 145
    - *Antheraea polyphemus*, 123
    - *Basilarchia arthemis*, 121
    - *Dasychira plagiata*, 19
    - *Dasychira vagans*, 127
    - *Datana ministra*, 135
    - *Gluphisia septentrionis*, 135
    - *Halysidota tessellaris*, 127
    - *Haploa confusa*, 129
    - *Heterocampa guttivitta*, 135
    - *Hyalophora cecropia*, 123
    - *Lochmaeus bilineata*, 135
    - *Lochmaeus manteo*, 133
    - *Lophocampa maculata*, 127
    - *Nymphalis antiopa*, 121
    - *Nymphalis vau-album j-album*, 121
    - *Orgyia antiqua*, 19, 127
    - *Orgyia leucostigma*, 19, 127
    - *Orthosia hibisci*, 137
    - *Schizura concinna*, 131
    - *Schizura unicornis*, 131
    - *Tolype velleda*, 129
  - Caterpillars, tent
    - *Malacosoma disstria*, 147, 229
  - Gall formers; aphids
    - *Eriosoma americanum*, 159
    - *Eriosoma lanigerum*, 159
  - Gall formers; mites
    - *Aceria ulmi*, 159
  - Leaf rollers
    - *Archips argyrospila*, 165
    - *Archips negundana*, 165
    - *Choristoneura rosaceana*, 169
    - *Pandemis limitata*, 167
  - Leaf skeletonizers
    - *Datana ministra*, 135
    - *Lochmaeus manteo*, 133
    - *Schizura concinna*, 131
  - Leaftiers
    - *Canarsia ulmiarrosorella*, 171
  - Loopers
    - *Alsophila pometaria*, 175
    - *Anacamptodes ephyraria*, 183
    - *Anavitrinelia pampinaria*, 179
    - *Biston betularia cognataria*, 181
    - *Campaea perlata*, 177
    - *Ennomos magnaria*, 177
    - *Ennomos subsignaria*, 177
    - *Erannis tiliaria*, 177
    - *Euchlaena marginaria*, 179
    - *Eutrapela clemataria*, 179

- ***Ulmus americana* continued**
    - *Hydriomena furcata*, 185
    - *Hypagyrtis unipunctata*, 179, 185
    - *Lambdina fiscellaria*, 27, 177
    - *Lycia rachelae*, 181
    - *Melanolophia canadaria*, 185
    - *Melanolophia signataria*, 185
    - *Nacophora quernaria*, 181
    - *Nematocampa limbata*, 21, 143
    - *Nemoria mimosaria*, 143
    - *Operophtera bruceata*, 173
    - *Paleacrita vernata*, 175
    - *Phigalia titea*, 179
    - *Probole amicaria*, 179
    - *Prochoerodes transversata*, 179
    - *Protoboarmia porcelaria indicataria*, 127
    - *Selenia kentaria*, 143
  - Sawflies
    - *Cimbex americana*, 191
  - Scales
    - *Parthenolecanium corni*, 71, 215
  - Walkingsticks
    - *Diapheromera femorata*, 187
  - Webworms and their allies
    - *Hyphantria cunea*, 151
    - *Meroptera pravella*, 169
- Trunk or large branches, in wood
  - Ants, carpenter
    - *Camponotus pennsylvanicus*, 93
  - Horntails
    - *Tremex columba*, 239
  - Woodwasps
    - *Xiphydria tibialis*, 239
- Trunk or large branches, under bark
  - Beetles, bark
    - *Hylurgopinus rufipes*, 227
    - *Scolytus multistriatus*, 227
- Twigs or small branches, on bark
  - Beetles
    - *Scolytus multistriatus*, 227
  - Scales
    - *Chionaspis furfura*, 215
    - *Lepidosaphes ulmi*, 215
    - *Parthenolecanium corni*, 215
    - *Quadraspidiotus perniciosus*, 215
  - Treehoppers
    - *Ceresa bisonia*, 161
    - *Ceresa diceros*, 161

- ***Ulmus pumila* Linnaeus** (Siberian elm)
  - Trunk or large branches, under bark
    - Beetles, bark
      - *Hylurgopinus rufipes*, 227
      - *Scolytus multistriatus*, 227
  - Twigs or small branches, on bark
    - Beetles
      - *Scolytus multistriatus*, 227

- ***Viburnum*** (viburnum)
  - Roots or basal stem, in wood
    - Moths, clearwing
      - *Synanthedon viburni*, 235
  - Roots or basal stem, under bark
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